

PUBLIC WORKS

May
1960

CITY, COUNTY AND STATE

Complete In This Issue:
**DESIGN OF SMALL
WATER TREATMENT
SYSTEMS**
pages 109 to 133

SLURRY SEALS
For Street Betterment
page 99

Saving \$1,000 a Week on
REFUSE COLLECTION
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SPRAY DISPOSAL
Of Domestic Wastes
page 137

How a County Builds
SOIL CEMENT ROADS
page 143

PAGE 5
LISTS ALL ARTICLES
IN THIS ISSUE



GALION 12-Ton Pneumatic-Tire Roller



Only Galion offers EQUA-MATIC front end construction

Through the automatic balancing action of three king pins, safe roller support is always assured when working over uneven or sloping ground. Galion's exclusive EQUA-MATIC design provides an equalizing movement straight up and down of all five steering wheels, and an oscillating up and down movement of the end wheel pairs. Thus, firm compacting contact is maintained with the surface at all times by the five wheels.

plus 18 other important features

- ROLL-O-MATIC or standard gear shift drive.
- SYNCHRO-MESH transmission.
- UNITIZED assembly provides easy access and servicing.
- AUTOMOTIVE-type hydraulic steering.
- LARGEST ballastable capacity in relation to overall size—in excess of 24,000 lbs. total weight with wet sand ballast.
- EIGHTY horsepower gasoline engine.
- HEAVIEST construction—8,400 lbs. metal weight.
- LOW center of gravity.
- 100% COVERAGE—treads of the nine tires overlap.
- WIDE RANGE of speeds—same range forward and reverse.
- SHORT drive shaft.
- DOUBLE drive chains to each pair of drive wheels.
- FOUR-WHEEL hydraulic service brake and independent parking brake.
- EXCELLENT visibility for operator.
- SHORT turning radius.
- FOUR large doors for ballast removal.
- SWIVEL seat, fully adjustable.

THE GALION IRON WORKS & MFG. CO.
General and Export Offices—Galion, Ohio, U.S.A.
Cable Address—GALIONIRON, Galion, Ohio



2239

GREATER STABILITY

Maximum stability and support across the entire front end of the roller is achieved by GALION'S three-point king pin suspension of the five steering wheels. PATENT PENDING.



SYNCHRONIZED 5-WHEEL STEERING

Each of the five steering wheels is adjusted to always steer in its own true arc. This design eliminates the pushing and gouging of material which results when no provision is made to compensate for arcing variations in multiple-wheel steering.



EASY SERVICING

Unitized assembly permits each wheel and wheel brake to be serviced individually, as well as the oil-tight double drive chains. The entire power train can be removed as a unit.

Write for literature.



MOTOR GRADERS & ROLLERS

"from Chicago"

sealtrode

Trademark

SEALED ELECTRODE FLOATLESS PUMP CONTROLLER

A new and valuable accessory for Sewage And Drainage Sump Pumps . . . exclusively available with "Chicago" Pumps.

SIMPLE OPERATION

No moving parts in the liquid. As liquid level rises in the wet well it exerts a hydrostatic pressure on a flexible bulb filled with a electrolytic solution of clear water and copper sulphate. The hydrostatic pressure squeezes the bulb, causing the solution to rise in the support pipe. The liquid level in the support pipe will always equal the liquid level in which the controller is submerged, since the density of both liquids are equal. As the liquid within the support pipe rises and falls, it makes and breaks electrical circuits with the electrodes, activating the pump starters through controller relays.

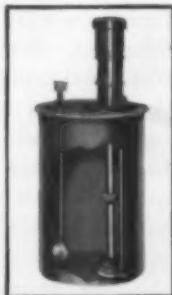
The SEALTRODE* Sealed Electrode Floatless Pump Controller has every advantage of other floatless controllers, plus these advantages of being sealed:

- Electrodes never become insulated and coated with grease, oil or soap.
- Electrodes are never affected by corrosive elements in sewage and drainage water.
- No moving parts in liquid.
- Low original cost . . . eliminates need for duplex float switches and float guide pipes.
- Low maintenance cost.

TYPICAL PUMP APPLICATIONS

SEWAGE PUMP SUMP PUMP

PATENT No. 2,797,702



Write direct, or contact Chicago Pump Company Distributors located in most principal cities, for bulletins and complete engineering data.



Putting Ideas to Work
FOOD MACHINERY AND CHEMICAL CORPORATION

HYDRODYNAMICS DIVISION

CHICAGO PUMP

622F DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

©1960 Chicago Pump

LAND IMPROVEMENT

IN LANE COUNTY, OREGON

Along the Oregon coast, Lane County's D6 cuts a road to the ocean for a new recreation area near Florence. Lane County, stretching from the Cascades to the Pacific, depends on its D6 and 18 other Caterpillar-built machines to carry out road maintenance and construction programs. Multimillion-dollar road programs, new state parks . . . these are the things being done in Lane County. County Road Engineer H. O. Walberg commented on their Cat-built equipment: "We're well satisfied with our Cat equipment for two big reasons . . . big production and little down time. And when we need dealer service, it's there! The D6 is particularly useful to us. It's small enough to work in tight places, but big enough to tackle tough jobs."

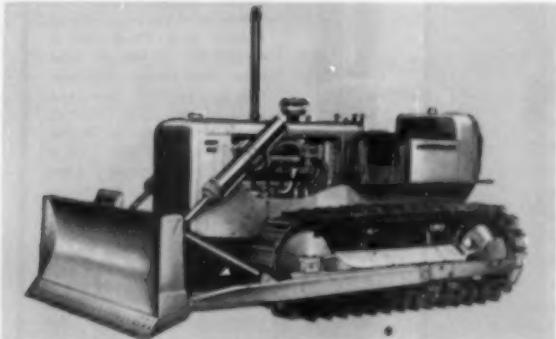


MACHINE IMPROVEMENT

BY CATERPILLAR

There's a new D6 . . . the Series B . . . just introduced by Caterpillar. On the same jobs, on tougher jobs, this new work-styled D6B sets production peaks unheard of from a machine in its size class. It has more than just improvements . . . the all-new compact Caterpillar Diesel Engine, the D333, boosts lugging ability 25%. A new integral hydraulic system (optional) puts power where it's needed . . . at the tools. Center-pivoted cylinder mounting gives increased lift/drop range. Under-the-hood location of tank, pump and valves permits convenient routing of hydraulic lines to bulldozer or implement cylinders . . . frees the front and rear for working tools. The operator's cockpit is all new. Controls make the tractor handle almost as if it knew what was needed next.

The exclusive Caterpillar oil clutch is standard on the D6B. It provides up to 2,000 hours of adjustment-free operation. Lifetime lubricated rollers need no lubrication until rebuilding . . . help roll up more operating time instead of repairs. The dry-type air cleaner removes at least 99.8% of all dirt from intake air. Can be serviced



in five minutes. Cuts maintenance time by as much as 75%. Optional hydraulic track adjusters are another time saver. A grease gun is all that's needed to assure proper track adjustment.

Now's the time to see the new D6B and its complete line of versatile attachments. See for yourself how the new D6B gets more work for your tax dollars.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

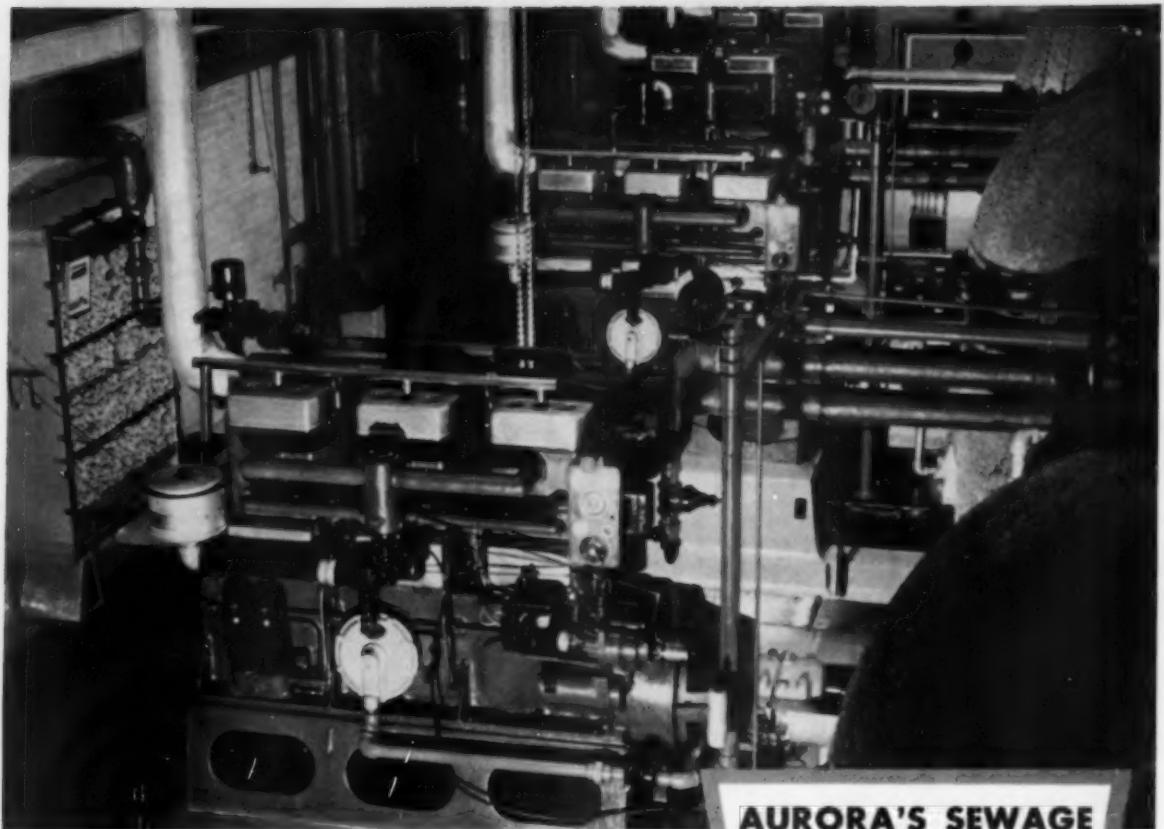
CATERPILLAR

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BORN OF RESEARCH
PROVED IN THE FIELD

MAY, 1960 • Volume 91, Number 5

Ten Steps for Successful Slurry Sealing	99	Developments in Asbestos-Asphalt Paving Mixes	145
A detailed outline of two methods used by the City of Fresno, Calif., to apply slurry seals to streets.		A. A. KALINSKE	
Selling Complete Sewage Treatment to a City	103	The Completely-Mixed Activated Sludge Process	146
When some upstream cities provide primary sewage treatment or less, citizens must be fully informed to sell them on complete treatment.		In this interesting modification of the activated sludge process, developed during the last decade, the necessity for overfeeding organisms in one part of the cycle and starving them in the next is overcome.	
R. L. SMITH and H. C. LEIBER		A. A. KALINSKE	
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JOSEPH A. SALVATO, JR.		Attendance in Texas exceeds 2500 per year.	
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for over 22 years



The Aurora Sanitary District, Aurora, Ill., installed two 75 hp, six-cylinder Climax pump engines in 1936. These direct-connected engines performed so well—always starting under load—that, in 1940 two 50 hp Climax engines in generator sets were added. All four engines had sewage gas and gasoline carburetors. In 1953, gasoline was replaced by natural gas as standby fuel. This gave the plant four-way safety—duplicate engines . . . two fuels . . . two ways to start generator engines . . . freedom from electric storm interruption. After 22 years, 8 months, pump engines had paid for themselves 4.78 times; generator engines 2.5 times after 17 years. Year after year Climax engines keep on making records like this. 40 to 610 hp; V-type—four models, 8 and 12 cylinder; in-line type—four models, 4 and 6 cylinder. Capable of operation on sewage gas, natural gas, butane, gasoline, or any combination. Send for complete power chart and bulletins.

AURORA'S SEWAGE
TREATMENT
PLANT
has been
POWERED
by these

CLIMAX ENGINES

CLIMAX ENGINE MANUFACTURING CO.
DIVISION OF WAUKESHA MOTOR COMPANY

FACTORY AT CLINTON, IOWA

CL-104

PUBLIC WORKS for May, 1960



A. PRESCOTT FOLWELL

A LEADING figure in public works engineering passed away on March 19. A. Prescott Folwell was 95 years old. His name had appeared on the mast-head of this magazine continuously for 54 years, and he contributed tremendously to better engineering over all that time.

His "Sewerage," published in 1898 and continuing through a dozen editions for 40 years, was an outstanding text developed from his teaching experience at Lafayette before becoming editor of Municipal Journal, the original name of PUBLIC WORKS. He later wrote other popular and useful engineering texts: but his greatest service in the educational field was rendered by his ability to make the magazine he edited a help and an inspiration to its readers. That he was able to do this during the 1940 to 1945 period, when all our younger physically fit men were in the service, and he was 75 to 80 years old, is the best tribute to his eternal youthfulness.

He was the kind of engineer one hopes to be and a gentleman of the very first order.

• • • •

Complaining About the Water Bill

"**W**ITH SOME shame at its amount," says one of our New York City residents, "we have recently paid a New York City water bill. "The shame is due to its smallness," he continues. "For unlimited and unmetered water the bill was exactly the same as it was twenty-three years ago. In 1937 dollars it might possibly have covered the cost of the water supplied, but in 1960 dollars it gives us the unpleasant feeling of having been subsidized for no good reason." Generally speaking, and in most places, water is woefully underpriced. This might be defensible except that the industry is being strangled for lack of adequate revenues. With the mounting need for more water and better water, it is high time that our water works people placed their rates on a more realistic basis, one geared to today's costs, not yesterday's.

In water as in everything else, in the long run we get only what we pay for. The sensible way to take care of present and future needs is to summon the courage to charge what it is worth. Every-

one will benefit—the water utilities in holding and securing top-grade personnel and in making necessary improvements and expansions; the manufacturers in supplying materials and equipment; and the consumers themselves in having enough water for all seasons and all purposes.

The Challenge of Maintenance

WITH THE glamor of construction and the spectacular expenditure of dollars on new facilities commanding attention in the current highway and street programs, public recognition and official acceptance of ever-important maintenance requirements is oftentimes lacking. Maintenance officials have traditionally had to do battle for the proper money, talent and personnel to perform their task.

This seems strange when considering that the maintenance engineer is charged with the responsibility of protecting not only the current investment in streets and highways, but also that made for many years past. Without such protection this investment would be short-lived indeed.

In maintenance a fertile field can be found for the training of young engineers, and a challenging assignment for the engineering skills, administrative talent and inventive bent of our highway officials.

Tools and Procedures for Destruction and for Construction

OUR GENERAL news media is pretty well filled with articles describing actual or potential tools for destruction, but there is little space given to the tools and equipment for better engineering and longer living. Not only are these tools—and the procedures for using them—now available but they are being used every day. The result of past employment of these tools and of the engineering knowledge for applying them is visible in our fine highways; our safe though sometimes inadequate water supplies; our advances in waste disposal; and in our other services for our citizens. It is unfortunate that these tools, the techniques and the skills of the leaders in this vital area of public service cannot gain the public recognition accorded to the potential agents of destruction. Interest and support for construction could result in a degree of progress we cannot now envision.





WILL PERFORM FOR A CENTURY WITH A RIVER ON ITS BACK

At left, you see a length of cast iron pipe being installed under the Floyd River in Iowa. This is part of a water feeder main which will reinforce the existing water supply system.

Despite the severe conditions of a river overhead, the inherent ruggedness of cast iron pipe promises at least a century of trouble-free performance, and rarely requires repairs or replacement.

And cast iron pipe's cement lining assures a continued full flow of water year after year. It's no wonder that more than 90% of the pipe used for water supply systems in our 50 largest cities is cast iron pipe!

CAST IRON PIPE RESEARCH ASSOCIATION.
Thos. F. Wolfe, Managing Director,
3440 Prudential Plaza, Chicago 1, Illinois



CAST IRON PIPE
THE MARK OF THE 100-YEAR PIPE

Who else... ...but HOUGH provides these facts?

This factual data on PAYLOADER four-wheel-drive, rubber-tired tractor-shovels in each of 1, 2, 3, and 4 yard sizes points up the advantages of their design, performance and safety features. Comparisons include all competitive units from manufacturers' printed specs as of April 1, 1960.



More Power: H-30 has 17% more horsepower than next most powerful machine in this category.

More Dumping Clearance and Reach: The H-30 has 4" more clearance and over a foot more reach.

Safety Boom Arms: All moving members pivoted in front of operator. **Exclusive** on the H-30.

Safety Ladder: Makes access to the operator's compartment easy and safe. Another **exclusive**.

"Full" Power-Shift Transmission: No manual shift, working to travel range. "PAYLOMATIC" transmission Hough designed and manufactured.

Four-Wheel-Brakes: **Exclusive** on the H-30 they permit equal stopping in both forward and reverse. Also sealed against dust and dirt.

"Operator's Choice" Brake Pedals: Dual pedals give the operator a choice of braking with or without transmission engaged. H-30 **exclusive**.

Closed Hydraulic System: Sealed and pressure-controlled hydraulic reservoir with renewable cartridge-type filter and fine-mesh screen. Another **exclusive** H-30 protective feature.

Separate Oil-Cooling Radiator: A fan-cooled "oil-to-air" heat exchanger cools transmission and torque-converter oil. Another **exclusive**.

Easy Accessibility: No other comparable unit has H-30 accessibility. Dip stick, filler cap, batteries, connections and service points reached from ground level.

More Power: H-70 has more horsepower than the average of 9 competitive gas and diesel units.

More Dumping Clearance: The H-70 has 4" more clearance than average of 9 competitive units.

Safety Boom Arms: Underslung design keeps the operator safe from all moving members.

Safety Ladder: Makes access to the operator's compartment easy and safe. An H-70 **exclusive**.

"Full" Power-Shift Transmission: No manual shift from work to travel ranges. "PAYLOMATIC" transmission Hough designed and manufactured.

Four-Wheel-Brakes: Hydraulic, power-boosted four-wheel-brakes with separate parking brake. Front brakes sealed against dust and dirt.

"Operator's Choice" Brake Pedals: Dual pedals give the operator a choice of braking with or without transmission engaged. A Hough "first".

Closed Hydraulic System: Sealed and pressure-controlled hydraulic reservoir with renewable cartridge-type oil filter and fine-mesh screen.

Separate Oil-Cooling Radiator: A fan-cooled "oil-to-air" heat exchanger cools transmission and torque-converter oil. An H-70 **exclusive**.

Torque-Proportioning Differentials: Transfer up to 24% more power to best traction wheels.

Easy Accessibility: Extra attention has been given to providing utmost accessibility to all service points.



15 cu. yd. **H-90B PAYLOADER**



18 1/4 cu. yd. **H-120 PAYLOADER**

More Power: H-90 has 24 more horsepower than the average of 8 competitive diesel models.

More Dumping Clearance: The H-90 has 10" more clearance than average of 8 competitive units.

Safety Boom Arms: Underslung design keeps the operator safe from all moving members.

Safety Ladder: Makes access to the operator's compartment easy and safe. An H-90 **exclusive**.

"Full" Power-Shift Transmission: No manual shift from work to travel ranges. Improved units have better operating characteristics.

Four-Wheel-Brakes: Power air brakes with big braking area on all four wheels assures easy, safe handling of the H-90 at all times.

"Operator's Choice" Brake Pedals: Dual pedals give the operator a choice of braking with or without transmission engaged. H-90 **exclusive**.

Closed Hydraulic System: Sealed and pressure-controlled hydraulic reservoir with renewable cartridge-type oil filter and fine-mesh screen. Another H-90 **exclusive** protective feature.

Separate Oil-Cooling Radiator: A fan-cooled "oil-to-air" heat exchanger cools transmission and torque-converter oil. An H-90 **exclusive**.

Torque-Proportioning Differentials: Transfers up to 24% more power to best traction wheels.

Easy Accessibility: Extra attention has been given to providing utmost accessibility to all points requiring checking and service.

Power-Steering: All "PAYLOADER" four-wheel-drive units have hydraulic power-steering.

More Power: H-120 has 38 more horsepower than next most powerful machine in this category.

More Dumping Clearance and Reach: H-120 has 4" more clearance, 6" more reach than next unit.

Safety Boom Arms: All moving members pivoted in front of operator. **Exclusive** on H-120.

Safety Ladder: Makes access to the operator's compartment easy and safe. Another **exclusive**.

"Full" Power-Shift Transmission: Hough-built, full-reversing, constant-mesh, countershaft-type with balanced rotating hydraulic clutches.

Four-Wheel-Brakes: Power air brakes with large braking area assure easy, safe handling at all times.

"Operator's Choice" Brake Pedals: Dual pedals give the operator a choice of braking with or without transmission engaged. H-120 **exclusive**.

Separate Oil-Cooling Radiator: A fan-cooled "oil-to-air" heat exchanger cools transmission and torque-converter oil. Another **exclusive**.

Better Balance: Exclusive use of lightweight, extra-strong "T-1" steel for box-section boom arms saves over a ton of "dead-weight" on the load-carrying end.

Better Stability: Counterweighted by approved use of dry ballast material in rear tires. Lower center of gravity, 50% of weight below rear axle. **Exclusive**.

Protection: Special dry-type air cleaner gives 99.8% dust removal efficiency under most adverse conditions. Sealed, pressure-controlled hydraulic system has cartridge oil filters and fine-mesh screens. **Exclusive**.

Extras: Canopy-type cab with windshield wipers and special lights is standard equipment.

HOUGH, PAYLOADER, PAYMOVER, PAYLOGGER, PAYLOMATIC and PAY are registered trademark names of The Frank G. Hough Co.

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Send data on all "PAYLOADER" models and attachments.

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State _____

**What Every
WATER
SUPERINTENDENT
Should Know
About**

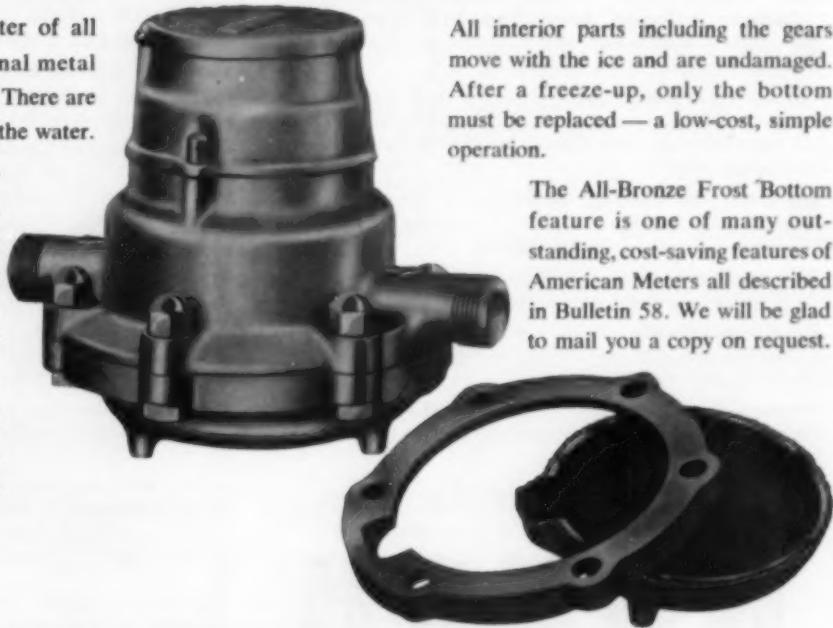


**a
n
AMERICAN METERS**

**All Bronze
FROST BOTTOM METER**

Now, a true frost bottom meter of all bronze construction . . . internal metal parts, meter body, frost bottom. There are no dissimilar metals exposed to the water.

When the ALL-BRONZE frost-bottom American Meter freezes, the center section breaks by tension immediately relieving the strain on all internal parts. The exact location and type of fracture are design controlled. Every American Frost-Bottom Meter breaks in the **same** manner, at the **same** pressure, at the **same** place.



All interior parts including the gears move with the ice and are undamaged. After a freeze-up, only the bottom must be replaced — a low-cost, simple operation.

The All-Bronze Frost Bottom feature is one of many outstanding, cost-saving features of American Meters all described in Bulletin 58. We will be glad to mail you a copy on request.

**BUFFALO METER COMPANY
INCORPORATED**

2920 Main Street

Buffalo 14, New York

ACID-RESISTANT, WATER-TIGHT, QUICK-CO尤LING JOINTS
for straight and offset concrete sewer pipe

with **TYLOX®**

"C" SERIES
flexible GASKETS

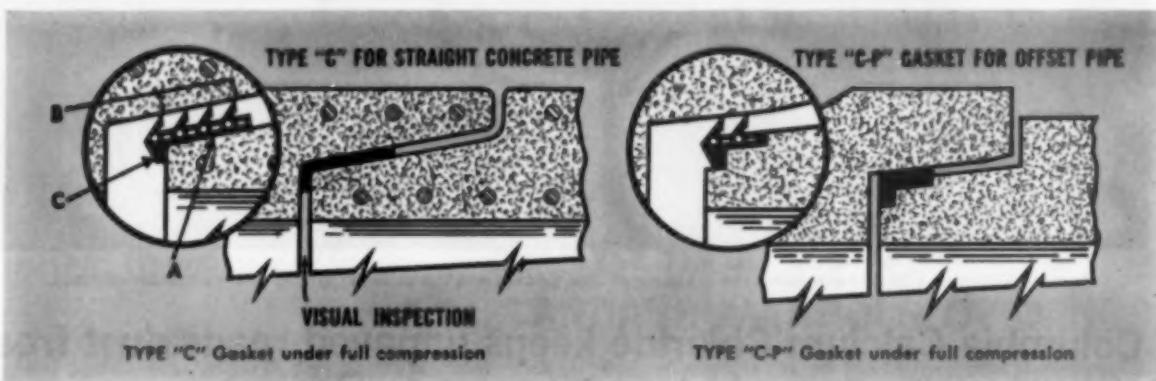


Sanitary Engineers can take advantage of the matchless efficiency of TYLOX Flexible Gaskets for coupling *any* concrete pipe sewer they design . . . because there's a specially designed TYLOX cross-section for *any type* of concrete pipe!

Type "C" Gaskets for straight, and type "C-P" Gaskets for offset pipe, provide the same high performance features you are accustomed to in famous Type "A" Gaskets . . . PLUS a visual inspection feature made possible by a flange which overhangs the edge of the pipe tongue, or tongue offset, according to the type of pipe. On pipe large enough to admit workmen, proof

of correct gasket positioning can be obtained by noting whether the inspection flange is evenly seated around the entire circumference of the joint. The larger the pipe, the more important this visual inspection feature becomes.

TYLOX "C" Series Gaskets are made for all pipe sizes, handle head pressures up to 50-feet, and are available in either rubber or neoprene. They may be applied to pipe at the pipe manufacturer's plant, or at the job site. Like all TYLOX Gaskets, they are immune to sewerage and industrial waste acids, and keep joints *water-tight* for the life of the pipe itself.



"C" Series TYLOX Gaskets consist of base A; sealing fins B; and inspection flange C. In addition to providing the inspection feature, the "locking" effect of the flange holds Gasket in true position as pipe is coupled. Design of the sealing fins is such that horizontal end-thrust forces causing "kickback" in some couplings, are eliminated in Tylox "C" Series Gaskets, assuring full seating and true alignment of pipe.



WRITE FOR DATA BROCHURE

Fully illustrated literature contains engineering data and installation information. Get it for your files. See why there are more TYLOX Gaskets specified for low head service than all other types of gaskets combined. Specify TYLOX Flexible Gaskets for jointing your waste disposal pipe lines.

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KENT, OHIO

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Columbia Calcium Chloride eliminates the nuisance of dust (above) and the threat to driving safety on unpaved roads.

Columbia Calcium Chloride keeps unpaved roads dust free ... reduces aggregate loss, too

This summer, use Columbia Calcium Chloride to keep dust down on the road where it belongs and not in the public's eye. And at the same time, cut maintenance and material costs.

Columbia Calcium Chloride keeps roads firm, smooth and dust free because it absorbs moisture from the air and retards evaporation from the road surface to hold down dust. Firmer surfaces made possible with Columbia Calcium Chloride give better bearing and less aggregate loss.

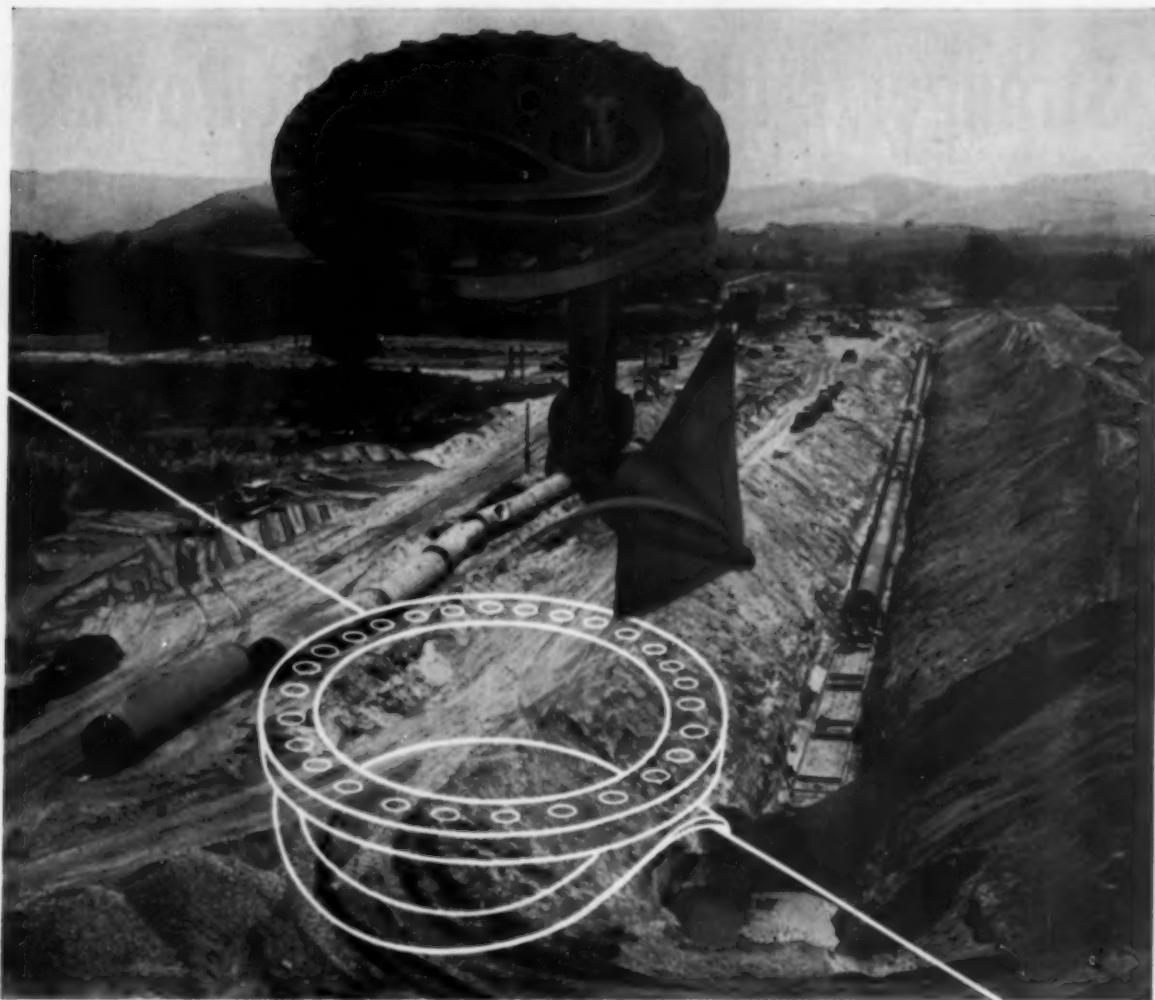
That's why public officials who know the importance of dust-free roads from a budget and public viewpoint, include Columbia Calcium Chloride in their dust control program. Their roads stay safe to drive on, pleasant to live by.

Start now to make all your unpaved roads trouble-free, economical Columbia Calcium Chloride roads. For more information, contact our nearest District Office or write our Pittsburgh Address.

You'll like doing business with Columbia-Southern

**columbia | southern
chemicals**

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New York • St. Louis • Minneapolis • New Orleans • Dallas • Houston
Pittsburgh • Philadelphia • San Francisco
IN CANADA: Standard Chemical Limited



quick, easy installation... **SPARLING 906 METERS**
FIT STANDARD MANHOLE OPENINGS

Meter installations on large pipe lines are simple with the Sparling 906 meter.

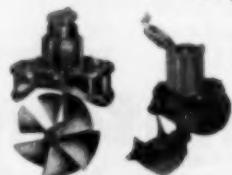
Unique design of the meterhead utilizes *standard* flanged manhole openings on new or existing pipe 16" to 72", including steel, reinforced concrete, and steel cylinder concrete. This use of standard flanged outlets cuts cost of new pipe construction, and saves time and money on installations in existing lines. Where required, steel saddle

and mounting skirts can be furnished to pipe manufacturer's specifications.

The Sparling 906 meterhead is complete. The propeller assembly slides directly through the opening and the meterhead is quickly and easily bolted into position ready for immediate use. Total flow is registered on a 6-digit, straight-reading totalizer. Accuracy is guaranteed within 2%.

Call your Sparling representative, or write for technical bulletin CF 365-1.

In addition to the 906, Sparling saddle meters are available in a complete range of sizes and working pressures for bolting, welding or wing and U-Bolt applications.

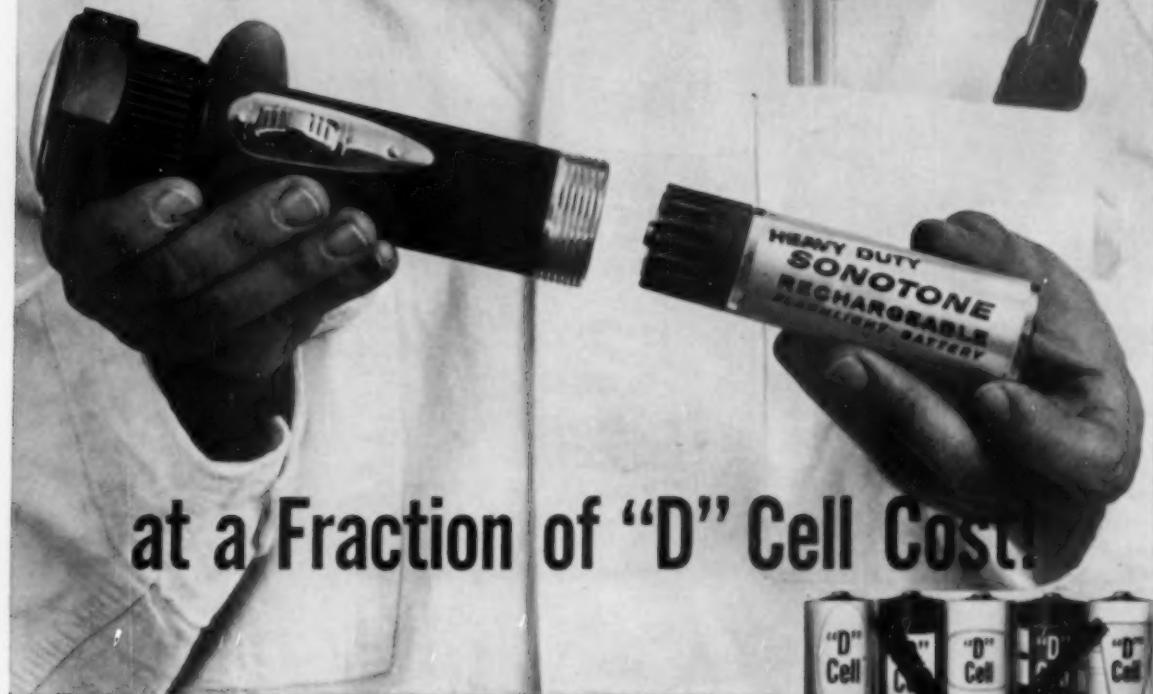


SPARLING
 WATER CONTROL EQUIPMENT

Hersey-Sparling Meter Company
 225 N. Temple City Blvd., El Monte, California

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 Branches in: Atlanta • Chicago • Cleveland • Dallas • Denver • Kansas City, Mo. • Roselle, N.J. • San Francisco • Seattle
 United Kingdom Affiliate: TYLORS OF LONDON LTD.

Stronger, Lifetime Flashlight Power



Heavy-Duty Sonotone Rechargeable Flashlight Battery Cartridge



To recharge, just unscrew cap ...



and plug overnight into any 110-120-volt AC outlet.

- A multi-use adaptation of the patented Sonotone sintered-plate, nickel-cadmium battery used in space missiles and jets.
- Gives at least 3 hours of strong, continuous light from a single charge with PR-6 bulb—or 1½ hours with full-powered PR-2 bulb.
- Dependable in extreme temperature and weather conditions.
- Can be recharged hundreds of times at about $\frac{1}{4}$ ¢ per charge.
- Sturdy, leakproof construction—aluminum jacket—electrically shockproof.
- Full-year guarantee under heavy industrial use—backed by Sonotone's leadership of over 30 years in precision engineering and service.



A completely new concept in flashlight battery efficiency and economy for industrial users! Replaces and outmodes any two "D" cells, for any purpose, in end-to-end use. Rechargeable overnight by plugging into any 110-120-volt AC outlet. Gives maintenance and service personnel a battery with a lifetime of use at a fraction of the cost of constantly replaced "D" cells. Dozens of applications—with railroads, aviation lines, municipal departments, public utilities and private industries. **Heavy-Duty Model FC-3** (\$9.95 retail)—subject to your usual discounts. Also **Standard Model FC-2** for home use (light lasts at least 1½ hours with PR-6 bulb)—\$7.95 retail. Write now for full details to:

Sonotone[®]

Battery Division, Dept. B54-50

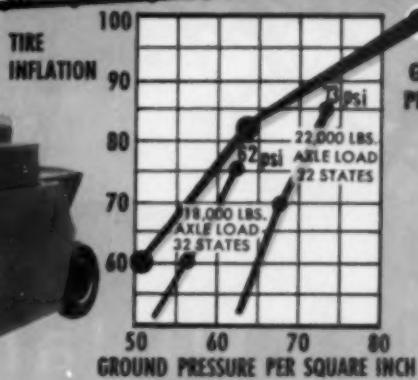
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Leading makers of fine transistor hearing aids, ceramic phonograph cartridges, speakers, microphones, electronic tubes, sintered-plate, nickel-cadmium batteries.

TAMPO

SP-900 SPELLS HIGHEST QUALITY ASPHALT MATS!



Tampo's rugged SP-900 self propelled pneumatic tired roller provides GREATER GROUND PRESSURE than truck load limits for MAXIMUM DENSITY rolling. Check current specs in your state.



- SURFACE PRESSURES ARE APPLIED WITHOUT DAMAGE TO UNDERLYING COURSES.
- TOTAL WEIGHT WITHIN AXLE LOAD LIMITS PREVENTS DAMAGING OVERLOADS ON HIGHWAY STRUCTURES.
- ACTUAL TIRE OVERLAP AT MAXIMUM INFLATION PREVENTS RUTS AND RAVELING.
- VISIBILITY AND MANEUVERABILITY ARE JUST RIGHT FOR INTERSECTION WORK.
- HIGH SPEED AND LOW COST PUT THIS ROLLER FROM JOB TO JOB FASTER, AND ON THE JOB AT BEST ECONOMY.

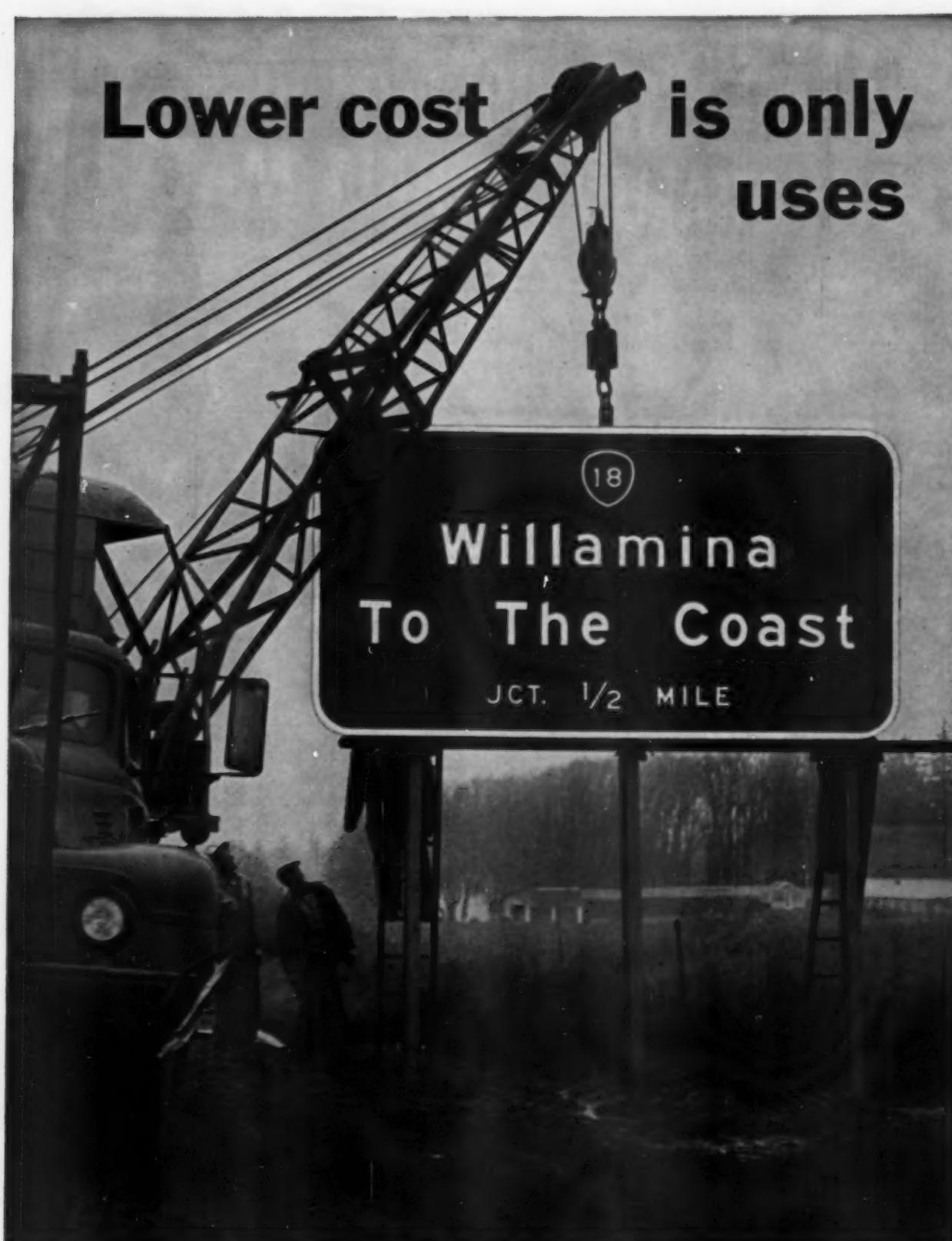
Increased asphaltic mat density specifications require high unit ground pressures under the roller tires. These higher unit pressures (exceeding truck tire contact pressures) densify the mat beyond traffic stress, tighten surface structure, prevent traffic grooving, decrease raveling and seal longitudinal joints. The densities obtained by Tampo's SP-900 pneumatic tired roller are more uniform and exist longer in the mat—add both life and quality to the surface.

TAMPO

MANUFACTURING COMPANY

P. O. BOX 4248, STATION A • 1146 W. LAUREL ST.
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**Lower cost
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18
Willamina
To The Coast
JCT. 1/2 MILE

New colorfast green overlaid plywood with reflective button legend and border is used for green background direction signs.

one reason why Oregon signs of overlaid plywood

MODERN REFLECTORIZED OVERLAIRED PLYWOOD signs do a better job for the taxpayer as well as the motorist in Oregon.

State highway officials estimate the overall cost of an overlaid plywood sign installation averages 20 percent less than other acceptable materials. Savings are based on lower basic material costs, faster fabrication and finishing (neither sign face nor back is painted; reflective legend is applied direct)—plus elimination of the need for special back framing on signs up to 40 square feet in area.

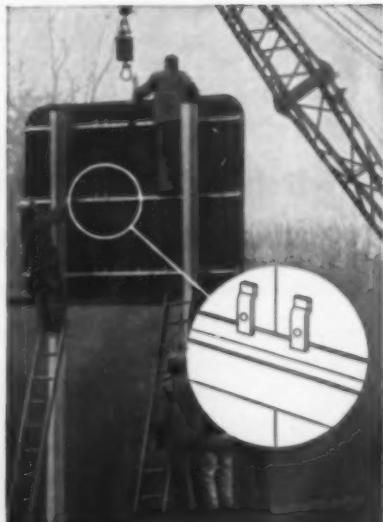
But lower cost is only part of the story. Basically, Oregon uses overlaid plywood because it makes a strong, good-looking sign that stands up under prolonged weathering and deliberate or accidental abuse.

All told, the state maintains over 100,000 signs; 47,000 informational, 20,000 warning and 35,000 regulatory. Ninety percent are reflectorized, with reflective legend and border applied directly to the overlaid plywood surface. Key directional signs are illuminated. Black high density panels are used for warning and regulatory signs. New color-fast green acrylic overlaid plywood is used for green background direction signs to conform to national color coding on Interstate and other highways.

FOR MORE INFORMATION (detailed specifications, application data, etc.) write:
DOUGLAS FIR PLYWOOD ASSOCIATION

TACOMA 2, WASHINGTON

—an industry-wide organization devoted to research, promotion and quality control
Always specify by DPPA grade trademarks



New panelized sign system used on recent Oregon installations employs standard aluminum girts and special clips. System is highly economical, permits flexibility in sign sizes and shapes. Developed by Douglas Fir Plywood Association, it meets all AASHO standards.



Medium density overlaid plywood is for plain painted signs; high density requires no paint protection and permits direct application of reflective sheeting. New acrylic overlay comes in green and white for signs with painted or reflectorized legend.



Sticky clay quits sticking—with exclusive 4-in-1 bottom dumping. Opening this clam pulls the material from bucket surfaces—gravity pull does the rest. You get positive 4-in-1 dumping, even of wet, sticky materials that idle ordinary, roll-forward buckets!

"Several machines in one save us time, labor expense, and additional equipment cost," states E. L. Quisenberry, Town Manager, Farmville, Va. Here their Turbocharged, 6-cylinder TD-9 Four-in-One is covering refuse evenly on-the-go with easily-controlled "carry-type scraper" action. Operator then uses compactor-plate action to iron-down the cover. No other rig even approaches 4-in-1 efficiency and economy operating the sanitary landfill!

Exclusive earth-peeling "carry-type scraper" action "bolts" material into the bucket—as this new 6-cylinder TD-9 Four-in-One accurately grades for streets, sidewalks, and driveways in a new Cleveland, Ohio, suburb. Outfit practically eliminates handwork follow-up!



How to replace a whole spread of with a clam-action

Switch machine-actions instantly
to efficiently do any job at hand!



"Greatest rig ever made for land clearing" declares operator K. G. Sanders. "We handle jobs ordinary loaders can't do." Clearing right-of-way for Big Dalton Flood Control Project near Covina, California. This TD-15 "clams on" to multi-ton stumps other buckets couldn't budge—loads these "impossibles" and wood-and-mortar building debris, with ease!





specialized rigs

4-in-1



“The 4-in-1 adapts to every job!” reports J. J. Surovik, Franklin, Pa. “It gives all-around versatility to handle all phases of the work.” Clamshell action “surrounds” loose materials—speedily heaps the bucket every pass. Preparing for paving on Erie, Pa., street, this TD-9 Four-in-One grades with inch-dose accuracy!

Using “rock-busting” 4-in-1 pry-action to rip up old pavement and make way for a Toledo, Ohio, parking lot. Area is then leveled and graded, and prepared for resurfacing by the precisely-controlled, clam-action TD-6 Four-in-One! Pry-out force of the TD-6 is 18,600 lbs—and a whopping 43,000 lbs on the 3 cu yd TD-20!

Fingertip easy, you move the selector lever—to instantly switch the 4-in-1 to the machine action needed to do the job at hand!

Load, bulldoze, strip, cover, excavate, clear, compact, grade, develop sites, landscape, and also beat any other rig on the market operating the sanitary landfill. Any of the five clam-action 4-in-1 sizes ($\frac{3}{4}$ to 3 cu yd) can give your community this exclusive versatility unlimited!

You get a whole equipment spread of actions in the clam-action 4-in-1. Each big-capacity action “doubles” for one or more specialized machines. You adjust and control hydraulically each 4-in-1 action, to get an amazing range of job-handling working positions!

Price all the machines the 4-in-1 can replace for your community—then total up the thousands of dollars you’d save with 4-in-1 ability to handle multi-operation jobs. See how only International Drott gives you 6-cylinder wallop and smoothness in all four diesel models—plus sintered metal faced engine clutch full-torque efficiency—plus exclusive dual-protected Dura Roller upkeep ease—plus exclusive, shock-swallowing Hydro-Spring performance protection! See your International Drott Distributor for a 4-in-1 demonstration!

International Harvester Company, Chicago 1, Illinois
Drott Manufacturing Corp., Milwaukee 15, Wisconsin



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When you need large diameter pipe, especially 12 $\frac{1}{4}$ " thru 48", L. B. Foster Co. can supply all you need from any one of its seven nationwide warehouses. And where's the "plus"? It's the "Faster From Foster" service that speeds your order.

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Also, check Foster for savings on Structural Grade pipe—ideal for non-pressure use, and for water well casing and pump columns.

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Los Angeles 5, Atlanta 8, Cleveland 35.



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**PUBLIC
WORKS**



George W. Kelsey is senior vice president and a director of B-I-F Industries, Inc., Providence, and is president of the Water and Sewage Works Manufacturers Association. He joined B-I-F Industries in 1938 as Industrial Sales Manager, was elected a director in 1944 and vice-president in 1947.

He is a graduate of Stevens Institute of Technology with an ME degree and is a registered professional engineer in New York. Before joining B-I-F Industries, he was with Tidewater Oil Co., served as Associate Professor at Rutgers in charge of industrial organization and management and was a consulting engineer, specializing in marketing research.

His public service and civic affairs contributions have been notable and are too numerous to list fully here, but include Chairman for the United Fund for Providence and 21 nearby communities in 1958; member of the Board of Trustees of State Colleges of Rhode Island; member of the Board of Directors of the Blue Cross of Rhode Island; and in 1957 Chairman of the National Resources Conference conducted in Providence.

Currently he is contributing largely to the programs now being conducted by AWWA and WSWMA for the much needed betterment of public water works facilities and the conservation of the nation's water resources. The cover picture shows him with the device representing the National Water Institute, an organization dedicated to better water works service.

Mr. Kelsey and his wife, the former Marion Field, have a daughter, two sons and eleven grandchildren. Mr. Kelsey's hobbies are golf, teaching and writing.

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Go North . . . East . . . South . . . West . . . you'll see Horton Elevated Steel Water Tanks on the skylines of America's *most progressive* cities. Landmarks of municipal progress, these structures combine beauty and prestige with efficient water system planning.

Horton tanks are designed to satisfy the increased water requirements of growing communities. They provide dependable gravity pressure water storage and assure these benefits:

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- Welded construction providing trouble-free service life with a minimum of maintenance
- All CB&I structures are built to AWWA standards

The specific answer to your water storage requirements can be found in the wide range of capacities and designs of modern elevated structures offered by CB&I:

WATERSPHERES® are graceful and contemporary in design. They provide maximum storage capacity in a functional, easy-to-paint and maintain structure. They are available in capacities from 25,000 to 250,000 gallons.

WATERSPHEROIDS® are big brothers to Waterspheres, differing only in size and shape. Waterspheroids range in capacity from 200,000 to 500,000 gallons. Both structures are designed to allow use of the base of the column as a pump or storage house . . . eliminating the need and expense for separate buildings. Write for *Watersphere and Waterspheroid Bulletin*.

SPHEROIDAL TANKS are available in several variations of the basic design to meet individual requirements. Capacities range from 200,000 to 3,000,000 gallons. They can be built with a large central riser in smooth or a fluted design; or the central portion can be supported on an inner circle of columns. Write for *Bulletin on Horton Elevated Tanks of Large Capacity*.

ELLIPSOIDAL-BOTTOM TANKS provide relatively large diameter and shallow depth. They have pleasing proportions and reduce the variation in pressure as water is used from them.

RADIAL-CONE TANKS provide the advantages of elevated storage in a tank of large capacity with a low range in head. They have smooth lines, are easy to maintain and are available in capacities up to 3,000,000 gallons. Can be furnished with or without a balcony.

STANDPIPES fulfill the water storage needs of many communities. Horton structures are particularly adaptable to special decorative treatment if desired. (See photo.)

STEEL RESERVOIRS provide gravity pressure where natural elevations are available or where large storage capacity is needed at ground level. They can be designed to meet *any size* or capacity requirements. A variety of roof types can be furnished. Horton Steel tanks will not crack or leak due to uneven settlement. Routine preventive maintenance will provide long service life. Write for a copy of *Horton Steel Reservoirs and Standpipes*.



WATERSPHERE at Griffith, Indiana has 200,000-gallon capacity; is 88 ft. to the bottom.



MHS/SCB

HORTON RESERVOIRS serving City of Fort Worth, Texas. Each has 8,000,000-gallon capacity.

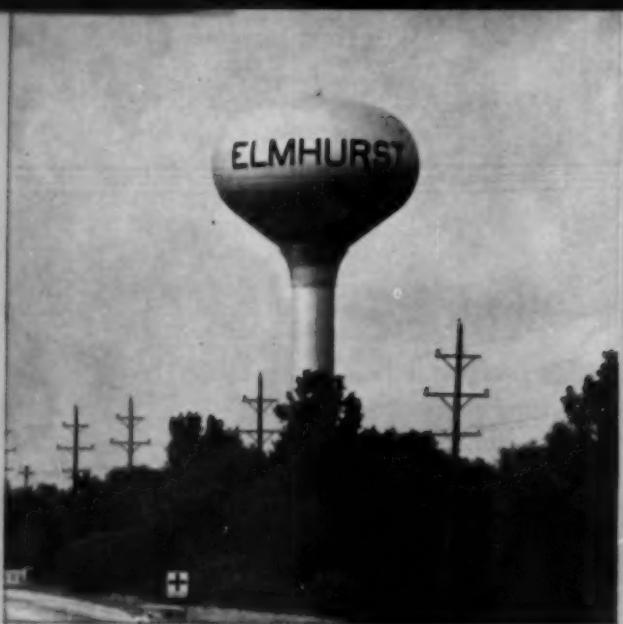


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CHICAGO 4, ILLINOIS

OFFICES AND SUBSIDIARIES IN PRINCIPAL CITIES THROUGHOUT THE WORLD





WATERSPHEROID serving Elmhurst, Illinois
has 900,000-gallon capacity; is 100 ft. to bottom.



SPHEROIDAL elevated tank at Wheaton, Illinois
is 130 ft. to bottom; has 1,800,000-gallon capacity.



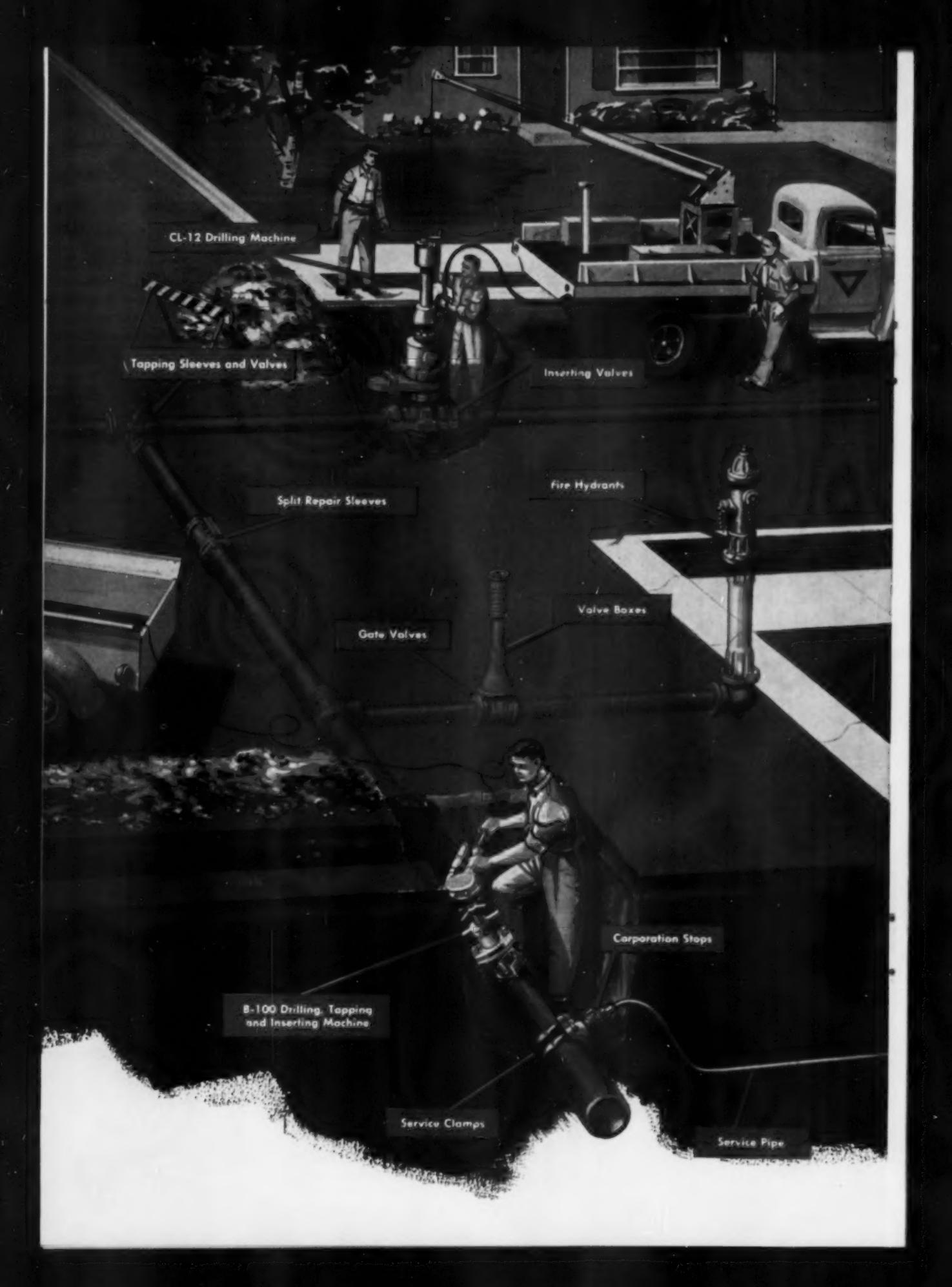
ELLIPSOIDAL-BOTTOM tank at
Bremen, Indiana has 300,000-
gallon capacity.



RADIAL-CONE elevated tank at
Manhattan, Kansas has capacity
of 900,000 gallons.



ORNAMENTAL STANDPIPE at
Clearwater, Florida has capacity
of 1,000,000 gallons.



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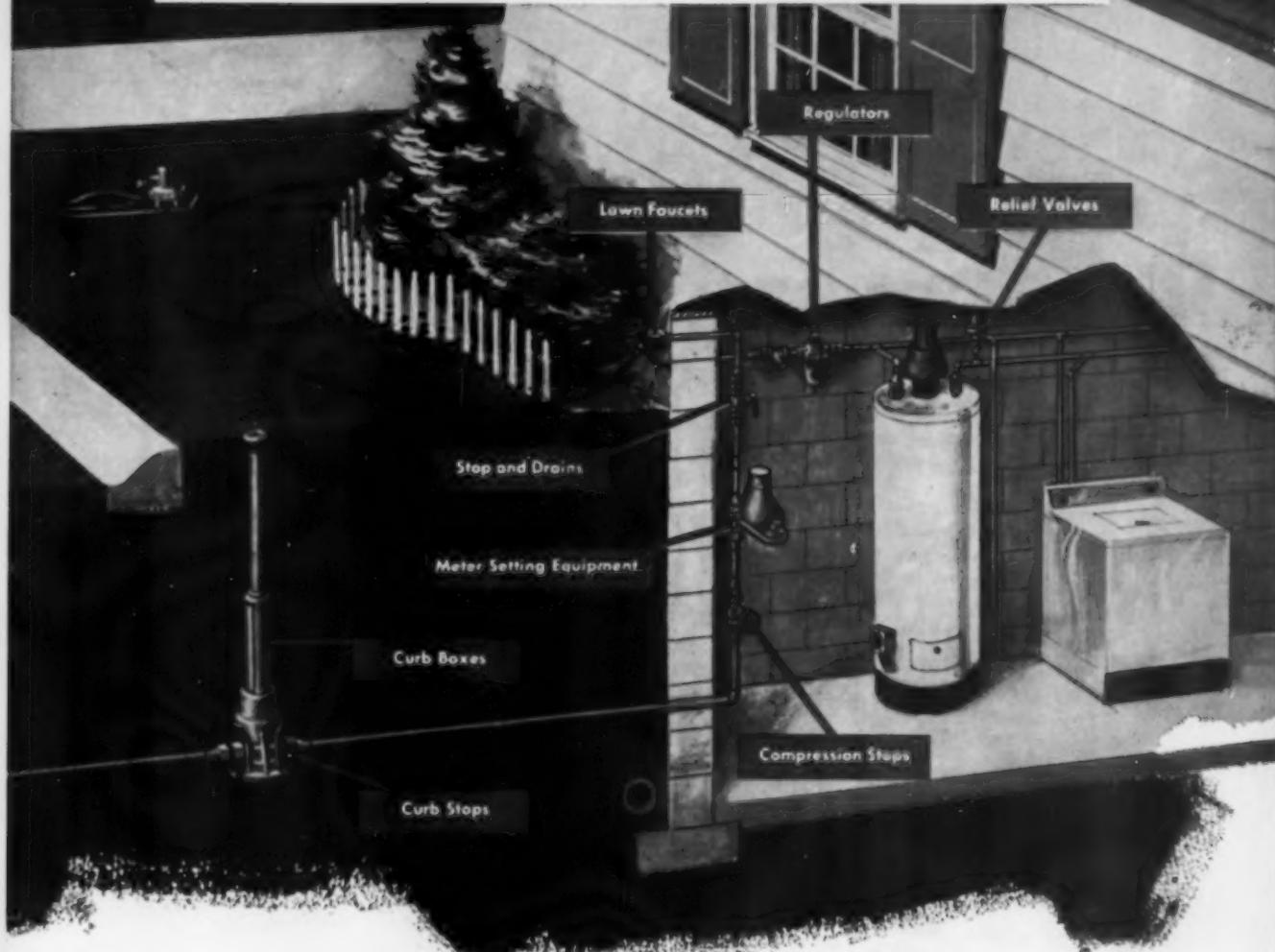
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Factories at: Decatur, Chattanooga, Los Angeles;
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Dade County Gets New Trash Collector

New Rig Speeds Trash Pickup

Some surprised Dade home owners have seen the first harbinger of Dade's long awaited trash removal program.

A giant mobile crane of the type Metro plans to use is on a working demonstration tour in the county.

"I never saw people so happy in my life as when they saw it go down the street picking up trash piles," said Harris N. Buckner, Metro Waste Division chief. "Another trailer would take its place behind the crane."

The unit, which consists of a crane and self-packing trailer, was designed at the suggestion of Metro officials and is the only one of its kind in the country.

NEEDS TWO MEN

"This piece of equipment can cover a route in a third of the time required by hand labor," Buckner says happily.

"It requires only a driver, who doubles as crane operator, and one laborer to clean up. The crane can remove as much rubbish in one bite as a laborer in 20 or 30 minutes."

In addition, Buckner said, a shuttle system would be used so that when one trailer was filled

Buckner is pushing for Metro to okay the purchase of four cranes and eight trailers as a start on the trash pickup program. COSTS \$30,000

A single complete unit is worth about \$30,000 and the extra trailer would add to this cost.

Buckner anticipates that the units, when and if purchased, would be split between north and south ends of the county in areas yet to be chosen. The \$6 a year trash pickup fee would apply as soon as pickup begins in a given area, he said.

Car
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"I never saw people so happy in my life as when they saw it go down the street picking up trash piles," said Harris N. Buckner, Metro Waste Division Chief.

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HOBBS HYD-PAK TRAILER!

A refuse collection unit like this is big news in Miami, Florida, or anywhere else. It's a trailer specially designed by the HYD-PAK division of Hobbs Trailers and now available to municipalities and private contractors across the nation.

It can handle all types of refuse, from gar-

bage to tree trimmings to apple boxes. Its hydraulic packer blade can compress 11 tons of refuse into the 35-yard storage compartment.

Where the pickup runs are long, where the routes have a high density of refuse, where the dump-sites are far away — this is the place for the HOBBS HYD-PAK trailer. Built by trailer people with years of experience, this unit may well be the answer to your modern-day refuse disposal problems. Write for full information today.

"It requires only a driver, who doubles as a crane operator, and one laborer to clean up. The crane can remove as much rubbish in one bite as a laborer in 20 or 30 minutes."

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*Which will you
Retire First...
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Will your bond-financed sewer system serve for generation after generation, far beyond the date the last bond is paid? Or will it have to be replaced before the bonds are retired.

The surest way to make certain today's dollars are buying generations of dependable service is to specify Clay Pipe . . . *it never wears out*. Clay Pipe does not rust, rot, corrode, or disintegrate. New long lengths with factory-made compression joints make Clay Pipe easier to install and tighter than ever before. Clay Pipe handles ground garbage, detergents, hot liquids, chemicals, acids, anything that empties into the sewer. When you specify Clay Pipe you'll never have to apologize for it or explain any failures. You'll be sure it will still be in service long after the bonds have been retired . . . Only Clay Pipe has *all* the features you can trust!



C-229-4 A

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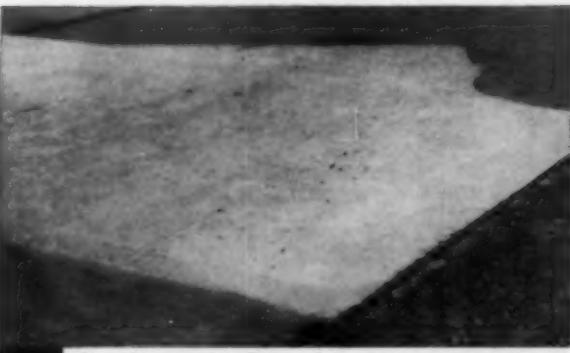
1. Scaled highway surfaces are being lastingly repaired in only a few hours by bonding new concrete to old with adhesives containing THIOKOL polysulfide polymer. The bond is stronger than concrete itself. Field and lab tests prove it.

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3. Adhesive with THIOKOL liquid polymer—made and sold commercially by several processors—is spread on prepared surface with brooms or heavy brushes. Thirty minutes later, while adhesive is still tacky, new concrete is poured.

4. Concrete is laid conventionally. It can also be worked out to a feather-edge without danger of later failure—so tenacious is the adhesive bond of new to old concrete.



5. Repair completed—road open as soon as concrete is cured. Similar repairs, in service since 1953, show no damage or effects of weather, wear and tear, even on the busiest highways.

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Thiokol Chemical Corp., 780 N. Clinton Ave., Trenton 7, N. J.

Please send me THIOKOL's helpful booklet "A New Type of Concrete-to-Concrete Bonding." Tells how to reduce remedial time and costs, and to keep roads in service.

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The engineering information in these helpful catalogs will aid you in your Engineering and Public Works programs. Just circle numbers you want on the reply card, sign and mail. This free Readers' Service is restricted to those actively engaged in the public works field of cities, counties or states.

NEW LISTINGS

You Don't Need a Big Plant to Get Big Savings

21. . . . in mechanical sludge dewatering. Now the smaller plant can cut power costs, eliminate use of chemicals and reduce labor. 4-page bulletin on the "Roto-Plug" sewage sludge concentrator shows how this is accomplished. Write for Bulletin 100 to Nichols Engineering & Research Corp., 70 Pine St., New York 5, N. Y., or check the card-number.

Make Your Utility Tractors Still More Versatile



Handbook on Spiraflo Clarifier Design

22. Comprehensive 36-page Bulletin 126 gives details of clarifier design, operating results, applications and full specifications for the Spiraflo clarifier for water and waste treatment. To get your copy check the reply card or write to Lakeside Engineering Corp., 222 West Adams St., Chicago 6, Ill.

Mark Pavements so They Will Stay Marked

23. Illustrated folder with list of 23 advantages of Traficade Plastic Safety Road-markers and detailed specifications and instructions on how to use available on request of Traficade Corp., 724 Transportation Bldg., Cincinnati 2, Ohio.

How to Select

Right Angle Drives

24. Data-filled Catalog 31 of Johnson Gear & Mfg. Co., Ltd., 8th & Parker Sts., Berkeley 10, Calif., makes it easy to select the correct right-angle gear drive for deep well turbine and other vertical shaft pumps. Includes details on the Johnson "Redi-Toro" gear drive. To get your copy just check the reply card.

Save One Man's Labor

25. With the new Wylie ROADMASTER self-contained asphalt plant, specifically designed for municipalities. New illustrated brochure tells all in 8 attractive pages. Write for it to Wylie Mfg. Co., Box 7086, Oklahoma City 12, Okla., or check the card.

Low Cost Erosion Control Treatment also Speeds Seed Germination

26. New super-highways call for new products and methods. You will welcome the information on Vulcanol spray mulch described in this new folder of Alco Oil & Chemical Corp., Trenton Ave. and William St., Philadelphia 3, Pa. Circle our card-number.

Coal-Tar Protective Coatings

27. . . . for buried or immersed steel and concrete structures are described in a new 13-page illustrated booklet. Contains detailed specifications, resistance properties and typical uses. For your copy of Bulletin CAC-11-598 write to Allied Chemicals Corp., Plastics and Coal Chemicals Div., 40 Rector St., New York 6, N. Y., or use the reply card.

New for 1960 Utility Tractors and Equipment

28. Fact-packed 8-page bulletin on the Case line gives full information on wheel and crawler tractors with loaders, angle dozers, lifts, and backhoes. To get Bulletin CUS-143 write to Utility Sales Div., J. I. Case Co., Racine, Wise., or circle card-number above.

Street Cleaner that Spends More Time on the Job

29. New vacuum street cleaner with vapor spray system to insure dustless operation and a king sized body to reduce dead time going to and from the dump is described in new brochure A-437-A. Address Baughman Mfg. Co., Jerseyville, Ill., or circle the card-number.

Stop Costly Engine Down-Time

30. Six page folder outlines steps that can be taken to minimize down time through use of manufacturers' parts to assure maximum service life. Full of helpful hints, all yours by asking for Form DE918 from Caterpillar Tractor Co., Peoria, Ill. Check the reply card.

Facts About Transite Pipe for Water Mains

31. Engineers can secure four pieces of illustrated literature that cover installation, operation and maintenance economics of Transite and Ring-Tite couplings for pressure mains. DS-335 is a material specification, TR-15A a Friction Loss of Head and Flow Powergraph, TR-62A an Installation Guide, and TR-160A in-service characteristics and case histories of water pipe. Tables of weights, sizes, pressure classes included. Address Johns-Manville, 22 E. 40th St., New York 16, N. Y., or check above number on card.

When Pipe Tops are in Order

32. You will welcome the facts and figures in the new folder on Mueller CL-12 drilling machine. Just ask for Form W-8881 of Mueller Co., 512 W. Cerro Gordo St., Decatur, Ill., or circle above number on the card.

Whatever Your Pumping Needs

33. . . . check the wide applications of Peerless Type A Horizontal split case centrifugal pumps. These continuous duty, general purpose pumps are described and illustrated for you in fact-filled 18-page Bulletin No. B-1300. Get your copy from Peerless Pump Div., 301 West Ave. 26, Los Angeles 31, Calif.

Nobody Loves Algae

34. And when you use Hyamine 2389 in your swimming pools there just aren't any algae to love. How and why this algicide works is fully described in a 12-page booklet, to be had from Rohm & Haas Co., Agricultural and Sanitary Chemicals Dept., Washington Square, Philadelphia 5, Pa. Just check the reply card.

New Light for Meter Readers and Trouble-Shooters

35. Every worker in the dark will welcome the assurance that his flashlight can now be permanently on the job, strong, bright and clear. These rechargeable flashlight battery cartridges outlast thousands of ordinary "one shot" cells. For literature write Battery Div., Sonostone Corp., Elmwood, N. Y., or circle the reply card.

Heavy Duty Corrosion Protection

36. Hot spray vinyl coatings that protect concrete or steel surfaces exposed to corrosive conditions in water or sewage treatment plants, pump stations, pipe lines, etc. are described in a new bulletin of Corrosion Control Co., 33 W. 42nd St., New York 36, N. Y. Application is easy—procedures covered in this bulletin. Get your copy by checking the reply card.

Liquid Flow Control Valves

37. Builders-Providence Butterfly Valves built to AWWA Specifications in sizes up to 72" and pressures up to 125 psi offer sturdy construction and durable materials throughout. These rubber-seated, tight-closing valves are available with choice of manual, pneumatic, hydraulic, or electric motor operators. Bulletin 650-20-1, B-J-F Industries, Inc., 345 Harris Avenue, Providence 1, R. I.

Speed Up and Improve Coagulation and Sedimentation

38. Coagulant aids for municipal water systems are described in 8-page bulletin HSP-919 of Hagan Chemicals & Controls, Inc., Hagan Center, Pittsburgh 30, Pa. Write direct or check this card-number.

When It Comes to Sowing Grass Seed

39. You will want to know about the fast, time-saving, money-saving Hale Power Seeders and Mulchers for roadsides, parks, and other large-area seeding. Bulletin No. 376 tells all. Address Hale Fire Pump Co., 708 Spring Mill Ave., Conshohocken, Pa.

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Sanitary landfill cost cut 25%

with "Spot-Turn"

OLIVER OC-46



Here's the catalog that's required reading for budget-minded cities: the OC-4 bulletin. It's heavy on job-application pictures and data—shows the OC-46 toolied-up with work-speeding, cost-saving equipment attachments. Ask us for your copy.

Absecon, New Jersey, keeps a sharp eye on the cost of its sanitary landfill operation. That's why this town is happy it bought an OC-46 "Spot-Turn" loader. The facts prove that a 25% saving is realized using the OC-46 versus the former method of hiring an outside contractor.

"'Spot-Turn' is the feature that saves us time and money," says George Gillespie, city councilman in charge of Streets and Roads Dept. The close-quarter maneuverability with shortest turn-around radius of the OC-46, plus its higher measure of diesel power, makes quick work of compacting and covering refuse. And the time saved by the OC-46 lets Absecon put it to work loading trucks for street and road maintenance, thereby gaining further savings.

Why not see...try the OC-46 yourself. It's the compact, big-job tackler that's sized right for city and township work—and lowest in its class for price!

LOOK TO OLIVER FOR YOUR BEST BUY IN WHEEL AND CRAWLER TRACTORS



THE OLIVER CORPORATION

Dept. 2232, 400 W. Madison St., Chicago 6, Ill.

To order these helpful booklets check the reply card opposite this page.



DIXON PAINTS LAST LONGER

This water tank shown is in Yonkers, New York and was painted over 15 years ago with Dixon paints. It's still getting good protection from sun, snow, sleet and rain!

This is not an unusual record for Dixon paints which, when properly applied, double normal paint life. This is proven out by Dixon customer records dating back for over 60 years. Cut your maintenance costs and give your water tank longer life with Dixon paint.

DIXON SILICA-GRAPHITE PAINTS FOR WATER TANK INTERIORS

These paints, which will not add odor, taste or color to the water, give maximum protection to the interior of your tank. When the tank expands and contracts the paint will not flake or crack because the interior paints, like the exterior paints, contain flake Silica-Graphite.

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JOSEPH DIXON CRUCIBLE CO. Jersey City 3, N. J.
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Paints For Bridges, Water Tanks & Other Metal Structures

238. Flake silica graphite paints for outdoor metals are described fully in literature from Paint Sales Div., Joseph Dixon Crucible Co., Jersey City 3, N. J. Check the reply card for details on these primer and protective paints.

Microstraining, Automatic Water Filtration

262. Glenfield Microstrainer provides high filtration, efficiency, automatic and continuous operation under 'open gravity conditions and small head loss. For literature check the reply card or write Glenfield & Kennedy, Inc., 96 North Ave., New Rochelle, N. Y.

PUBLIC WORKS for May, 1960



"Better check that weed killer, Barney, I think we've got it too strong!"

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May 1960

Please send me literature on the following items described in PUBLIC WORKS.

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Meetings and Conventions

Purdue Industrial Waste Conference

Purdue Memorial Union Bldg.
Lafayette, Ind., May 2-5. Sec., Don E. Bloodgood, Civil Engineering Bldg., Purdue Univ., Lafayette, Ind.

American Water Works Association

Pacific N.W. Section, Benson Hotel, Portland, Ore., May 4-6. Sec., F. D. Jones, W. 2108 Maxwell Ave., Spokane 11, Wash.

National Highway Users' Conference

Biennial Convention, Hotel Mayflower, Washington, D. C., May 10-12. Dir., Arthur C. Butler, 986 National Press Bldg., Washington 4, D. C.

National American Water Works Association

Americana Hotel
Bal Harbour, Fla., May 15-20. Exec. Sec., Raymond J. Faust, 2 Park Ave., New York 17, N. Y.

American Public Works Association

Central Calif. Chapter, Hacienda Motel, Fresno, Calif., May 16-18. A. M. Magnuson, Publicity Chm., Fresno, Calif.

Air Pollution Control Association

Hotel Netherland-Hilton
Fifth & Race, Cincinnati 2, Ohio, May 22-26. Exec. Sec., Arnold Arch, 4400 Fifth Ave., Pittsburgh 13, Pa.

Water Pollution Control Association

Michigan Sec., Park Place Hotel
Traverse City, Mich., May 23-25. Sec.-Treas., Donald M. Pierce, Michigan Dept. of Health, Room 331, Administration Bldg., Lansing 4, Mich.

American Water Works Association

New Jersey Sec., June 2, A.M. meeting — R. D. Wood Co., Florence, N. J., U. S. Pipe & Foundry Co., Burlington, N. J.; P.M. meeting — Riverton Country Club, Riverton, N. J. Sec.-Treas., Albert F. Pleibel, 683 Prospect St., Maplewood, N. J.

National Society of Professional Engineers

Statler Hotel
Boston, Mass., June 8-11. Exec. Dir., Paul H. Robbins, 2029 K St., N.W., Washington 6, D. C.

American Water Works Association

Pennsylvania Sec., Hilton Hotel
Pittsburgh, Pa., June 14-17. Sec.-Treas., L. S. Morgan, 413 First National Bank Bldg., Greensburg, Pa.

Water Pollution Control Federation

Virginia Sec., John Marshall Hotel
Richmond, Va., June 15-17. Sec.-Treas., Orval J. Hand, Hercules Powder Co., Hopewell, Va.

Water Pollution Control Federation

Central States Sec., Lorraine Hotel
Madison, Wis., June 15-17. Sec.-Treas., Scott E. Linsley, 2400 Childs Road, St. Paul 6, Minn.

Water Pollution Control Federation

Ohio Sec., Neil House
Columbus, Ohio, June 15-17. Sec.-Treas., E. B. Ransom, Div. of Sanitary Engineering, Dept. of Health, 101 N. High St., Columbus 15, Ohio.

American Public Works Association

The Coliseum, New York City, N. Y., Aug. 14-17. Exec. Dir., Robert D. Bugher, 1313 E. 60th St., Chicago 37, Ill.

Institute of Traffic Engineers

Edgewater Beach Hotel, Chicago, Ill., Sept. 11-15. Exec. Sec., David M. Baldwin, 2029 K St., N.W., Washington 6, D. C.

Water Pollution Control Federation

Philadelphia Sheraton Hotel
Philadelphia, Pa., Oct. 2-6. Exec. Sec., Ralph E. Fuhrman, 4435 Wisconsin Ave., N. W., Washington 16, D. C.

American Public Health Association

Civic Auditorium, San Francisco, Calif. Oct. 31-Nov. 4. Exec. Dir., Dr. Berwyn F. Mattison, 1790 Broadway, New York 19, N. Y.

American Bridge, Tunnel and Turnpike Association, Inc.

Sheraton-Atlantic Hotel
New York City, N. Y., Nov. 14-17. Exec. Sec., J. Allyn Stearna, Northcourt Bldg., 175 Main St., White Plains, N. Y.

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With a $\frac{1}{2}$ -yd. dragline bucket, BANTAM T-350 cleans out ditches alongside streets in Minden, La. High-speed production (up to 115 yds. per hr.) makes quick work of the job, lets Minden move its BANTAM on to other chores with savings in time and money.

City superintendent says:

"BANTAM is the best machine available for city work"

"We do anything we have to do with our BANTAM," reports Superintendent R. K. Whitlock of the Minden, Louisiana, Street and Water Dept.

Minden uses its BANTAM on all kinds of jobs—cleaning out drainage ditches after heavy rains, loading gravel and sand for street maintenance, etc. "BANTAM is mobile and fast—and much more productive," says Mr. Whitlock. "I'd recommend BANTAM to any city that wants efficient, low-cost equipment. It's the best machine available for city work."

BANTAM IS A REAL "BUDGET-SAVER"

BANTAM T-350 is the most practical tool for handling jobs all over town: sewer and water line extensions and repairs, drainage ditches, culvert work, street and alley repairs, sanitary landfill projects. It's tops for all excavating work, materials-handling or speeding

municipal building projects. As Superintendent Whitlock puts it, "BANTAM is as handy as a pocket on a shirt!"

Practical-sized BANTAM travels and works easily even in congested areas. BANTAM's big-rig features, 11-ton capacity and exclusive engineering advantages assure high speed, dependability and low operating cost.

II-ATTACHMENT VERSATILITY

With its 11 quick-change attachments, BANTAM is ready to work anywhere. And more than 25 optional features enable you to buy your BANTAM exactly as you want, to fit your specific job needs.

Let us prove to you why BANTAM is the most useful all-around rig you can own—the best investment for cities, towns and counties.

Here's another of three BANTAM models tailor-made for all kinds of city work—self-propelled BANTAM CR-350, with backhoe, prepares new subdivision streets for curb and gutter installation. One-man, one-engine operation; 11-ton capacity, automotive power steering; independent travel, swing and hoist, and now, higher travel speeds make the CR-350 a real saver for tight-pinched budgets. See the crawler mounted BANTAM C-350, too.

PW-284



301 Park Street, Waverly, Iowa
World's largest producer of truck crane-excavators

To order these helpful booklets check the reply card opposite page 34.

NEW LISTINGS (Cont.)

Welded Steel Pipe from 6 to 10 3/4" Diameter

268. High grade butt welded light-weight steel pipe from 8 to 16-gauge in 20, 30 and 40-foot lengths, plain or asphalt coated, with choice of joints. Also available up to 0.188 wall. Check uses for municipal water lines, irrigation, well casings and many other applications. Self explanatory literature from Valley Mfg. Co., Valley, Nebraska.

Welded Steel Pipe, Steel Piling and Corrugated Metal Culvert Pipe

273. Catalog on continuous electric welded steel pipe, cement mortar lined and coated pipe, coal tar lined and wrapped pipe, water well casings and corrugated culvert pipe is available from Southern Pipe & Casing Co., A Division of U. S. Industries, Inc., P. O. Box C, Azusa, Calif. Check the reply card.

This Expansion Bolt Will

Let You Sleep Nights

279. When you anchor the smallest fixture or the heaviest machinery in concrete, masonry or any non-frangible material with Wej-it bolts they stay anchored. Catalog with details and specifications, free from Kirel Inc., Kingston, N. Y., or circle our card number.

"Aircomb" Puts Teeth Into Aeration

294. Get full information on the "Aircomb" diffuser with self-cleaning non-clog teeth for use in pre-aeration, channel diffusion and activated sludge installations. Many advantages outlined in literature of American Well Works, 104 N. Broadway, Aurora, Ill. Check the reply card.

Hopto Hydraulic Excavators in 1/8 to 1/2 Yard Size

299. Five models of Hopto backhoes, all featuring heavy-duty boom, positive uninterrupted swing, 180° wrist action, dual purpose stabilizers and easy-to-use controls are described and specified in an informative 12-page booklet. Get your copy of Form H-5719 from

Badger Div., Warner & Swasey Co., Winona, Minn. Check the inquiry card.

Water, People and Hydrodynamics

302. . . . is the title of an illuminating booklet dealing with the world-wide problem of how to get water in adequate supply, when and where needed. Your copy can be had for the asking of Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill., or use the reply card.

Learn About Positive and Easy Valve Operation

304. "LimiTorque" Valve Operators provide push-button control that enables one man to open and close any type of valve quickly and dependably, provide full protection from damage during closing cycle due to torque limiting mechanism. LimiTorque is available for operation by any power source and is readily adaptable to all types of remote control. Catalog L-550 completely describes and illustrates operation and installation. Philadelphia Gear Corp., King of Prussia, Penn.

Use The Reply Card

One Locator Does Two Jobs

306. Transistorized "Dualtronic" Model LC-5T either pin-points detection of pipe, cables, mains, etc. or becomes a leak detector by plugging in a special microphone. To get all the facts write The Goldak Co., Inc., 1545 W. Glenoaks Blvd., Glendale 1, Calif., or check the inquiry card.

BUSINESS ADMINISTRATION

If You are Considering a trustee for a Bond Issue Check with Chase Manhattan

336. For details on how a bank serves as trustee for bond issues for any municipal or governmental unit, write The Chase Manhattan Bank, 40 Wall St., New York 15, N. Y.

WATER WORKS

In-Place Cement Lining of Small and Large Pipe

25. A catalog describing a process of in-place centrifugal cement lining of water, sanitary and storm drain pipelines from 4 to 144 ins. in diameter is available from the Centrifine Corp., Raymond International Inc., 140 Cedar St., New York 6, N. Y. Check the reply card for sample specifications and test results.

For Fast, Smooth Pipe Cuts

68. Descriptive literature on the Reed 4-wheel hinged pipe cutter which operates in close quarters, gives quick, easy right-angle cuts, and is available from Reed Mfg. Co., Erie, Pa. Check the reply card.

Efficient Coagulation With Ferri-Floc

30. Advantages claimed for Ferri-Floc as a coagulant include wide pH range, quick floc formation, manganese removal control of certain tastes and odors plus other aids in high quality water production. Check reply card for complete Ferri-Floc data. Tennessee Corp., Grant Bldg., Atlanta, Ga.

Easily Cleaned Long Run Filter Bed Media

70. Bulletins on Anthracite tell the reasons why selected, graded crushed anthracite is superior to sand as a filtering material. Have you made a full investigation? Write Anthracite Equipment Corp., Wilkes-Barre, Pa.

100 Page Book Helps Solve Water Problems

71. pH and Chlorine Control, A discussion of pH, Chlorine and Phosphate Control and descriptions of comparators for making colorimetric analyses. A 100 page booklet is available by checking reply card. W. A. Taylor & Co., 7304 York Road, Baltimore 4, Md.

Performance reports from Skooper owners prove . . .

KOEHRING



400 tons an hour with only 64 hp

OHIO — Koehring 205 Skooper with 2½-yard rehandling bucket was clocked loading from stockpile into trucks. Time studies showed production rate of approximately 400 tons an hour with the 64 hp machine! Discharge height: 12'-10" at beginning of dump, over 10' after dumping.



Macadam breakout easy with SKOOPER

LOUISIANA — On street resurfacing, old pavement was peeled off, loaded out by Skooper alone. No preliminary ripping or breaking. Powerful 7-foot level crowd action coupled with tremendous hydraulic break-out force enabled the operator to maintain grade, held grader work to minimum.

To order these helpful booklets check the reply card opposite page 34.

Convenient Reference Manual Covers Cast Iron Pipe, Valves and Hydrants

78. An 80-page manual, issued by R. D. Wood Co., Independence Sq., Philadelphia, Pa., presents specifications for "Sand-Spun" cast iron pipe and fittings, outlines types of joints available, lists dimensions and weights in convenient tables and includes, in addition, full engineering data on the Mathews and R. D. Wood fire hydrant and R. D. Wood gate valves.

Rust is a Loss;

Lick it with Rust-Oleum

92. Here is a new 1960 catalog, filled with new facts on how to defeat ravages of rust, protect every metal, and beautify it too. Catalog is a work of art in full color. For your copy write for Form No. 259 to Rust-Oleum Corp., 2799 Oakton St., Evanston, Ill.

Manual on Instrument

Accessories and Supplies

96. The 60-page loose-leaf book, Catalog 300, includes specifications, part numbers, and prices for more than 250 commonly furnished instrument parts and supplies. It is divided into 5 sections: Mechanical; pneumatic; electric-electronic; general; and tools and services. Check the reply card or write The Farnboro Co., Farnboro, Mass., for your copy.

Rapid Sand and

Pressure Filter Data

109. Rapid sand filters. A complete line of vertical and horizontal pressure filters, wooden gravity filters, and filter tables and other equipment. For engineering data, write Roberta Filter Manufacturing Co., 640 Columbia Ave., Darby, Pa., or check the reply card.

Design of Prestressed

Concrete Tanks

194. An 8-page technical Bulletin, T-19, on the Design of Prestressed Concrete Tanks, gives engineering data and formulas of general interest to anyone considering prestressed concrete for storage tanks. Check the reply card or write to The Preload Co., Inc., 353 Lexington Ave., New York 1, N. Y.

Before Taking Bids on Water Storage Tanks . . .

104. Learn more about GATX tanks, designed and fabricated by one of the nation's largest steel fabricators in accordance with AWWA specifications and municipal requirements. For detailed information, address Plate and Welding Div., General American Transportation Co., 135 So. La Salle St., Chicago 90, Ill., or circle our card number.

There's A New Hydrant

In Town!

119. New H100 Manual describes it and its bronze-to-bronze seat ring threads, permanent lubrication and unique seat removal. Latest addition to AWWA-conforming line of The A. P. Smith Mfg. Co., East Orange, N. J. Write them or check the reply card.

The Submersible Pump

You have Been Waiting For

141. Electric, fully submersible, portable, runs dry without damage, no priming, and other outstanding advantages. All are described in Flygt Bulletin B-801 of Flygt Corp., Housick Falls, N. Y. Address them or just circle the number on our card.

Helpful Reference Catalog on Waterworks Gate Valves

146. All necessary details on Double Disc Parallel Seat Gate Valves for waterworks use are provided in the attractive 36-page bulletin issued by Lediow Valve Mfg. Co., Inc., Troy, N. Y. Conveniently arranged design data shows all dimensions for 2" to 60" valves. Gearing, floor stands, operating devices are covered too. Get Bulletin 54W by checking the reply card.

Valve and Hydrant

Construction Details

161. A 72-page catalog-type bulletin, just completed, gives detailed data on construction and application of gate valves, check valves and hydrants for water works service. Write for Bulletin 5710 from Darling Valve and Mfg. Co., Williamsport, Pa., or check the reply card.

Manual on Filter Bed Agitators

204. General information specifications and installation data regarding the application of Palmer agitators, or rotary surface wash in vertical and horizontal pressure filters—round, square and rectangular open gravity type filters are covered in Manual from Palmer Filter Equipment Co., 822 East 8th St., P. O. Box 1696, Erie, Penna. Check the reply card.

Complete Catalog and Reference Data on Valves and Fittings

211. The entire M & H line of valves, fittings and accessories for water works, filtration, sewage disposal and fire protection are illustrated and fully detailed in Catalog 52 issued by M & H Valve & Fittings Co., Anniston, Ala. In addition to complete data on these products, there are many pages devoted to helpful engineering data. Every designer should have a copy.

Pipe Cutter for Cutting Large Size Pipe

234. An all-purpose pipe cutter that can cut pipe in or out of the ditch is described in a bulletin available from Ellis & Ford Mfg. Co., P. O. Box 308, Birmingham, Mich. Check the reply card for sizes and parts list.

Waterworks and Municipal Castings

293. Meter boxes and covers, valves and couplings, service boxes and manhole covers are covered in 24-page catalog. Check the reply card or write H. W. Clark Co., Mattoon, Ill., for full specifications.

Helpful Data on Swimming Pools

364. Data on injector nozzles for complete recirculation, fittings for correct drainage and other useful information for pool design are covered in Manual SP issued by Josam Mfg. Co., Michigan City, Ind.

(More listings on page 40)

... there's nothing like it — on wheels or tracks!

Take the full-revolving swing of a shovel, add the big bucket capacity and versatility of a tractor loader, and what do you have? A new concept in speed loading — with none of the usual drive-in, back-out waste motion of front-end loaders, none of the high tire or track maintenance of skid-turn operation. Skooper swings through continuous dig-swing-dump-return cycles without traveling — crowds 2-yard bucket along 7-foot level clean-up from "stand-still" position. Result: more versatility, more output, at substantial savings in fuel and maintenance costs. That's not all! Standard shovel-hoe-crane attachments make Skooper a doubly-sound investment for your carefully-budgeted dollars. Call Koehring® distributor, or write us for full details.

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Keeps traffic open during clean-up

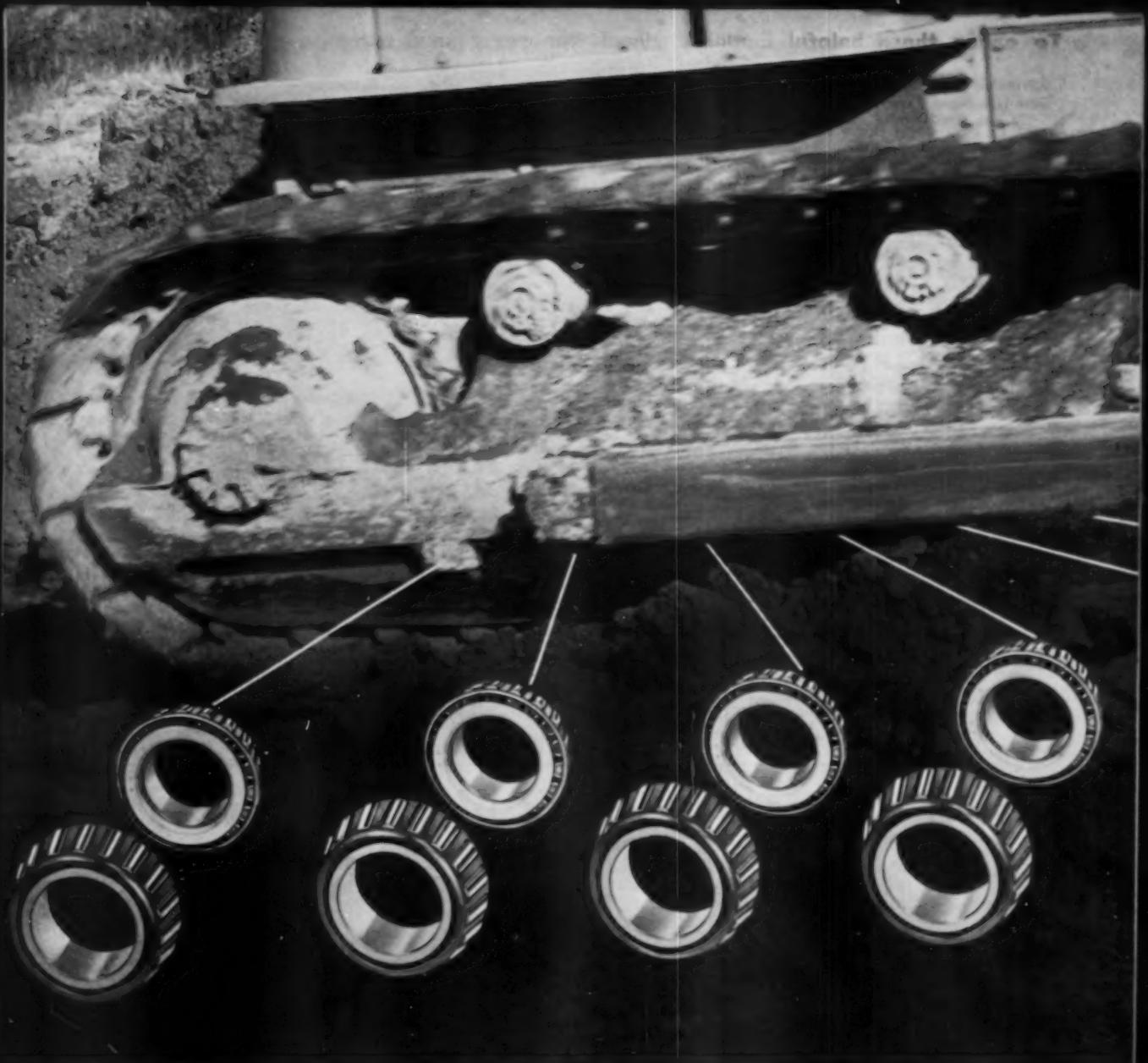
KENTUCKY — Highway department's Skooper cleans ditches, trims shoulders, banks, clears rock slides — stays in one lane, keeps other lane open to traffic. Skooper bucket reaches below the grade, above the grade, crowds straight ahead, or cuts at any angle of the bank slope.



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MORE WORK POWER

Reduced friction through use of tapered roller bearings in all Allis-Chalmers crawler tractors makes the difference in work power for you!

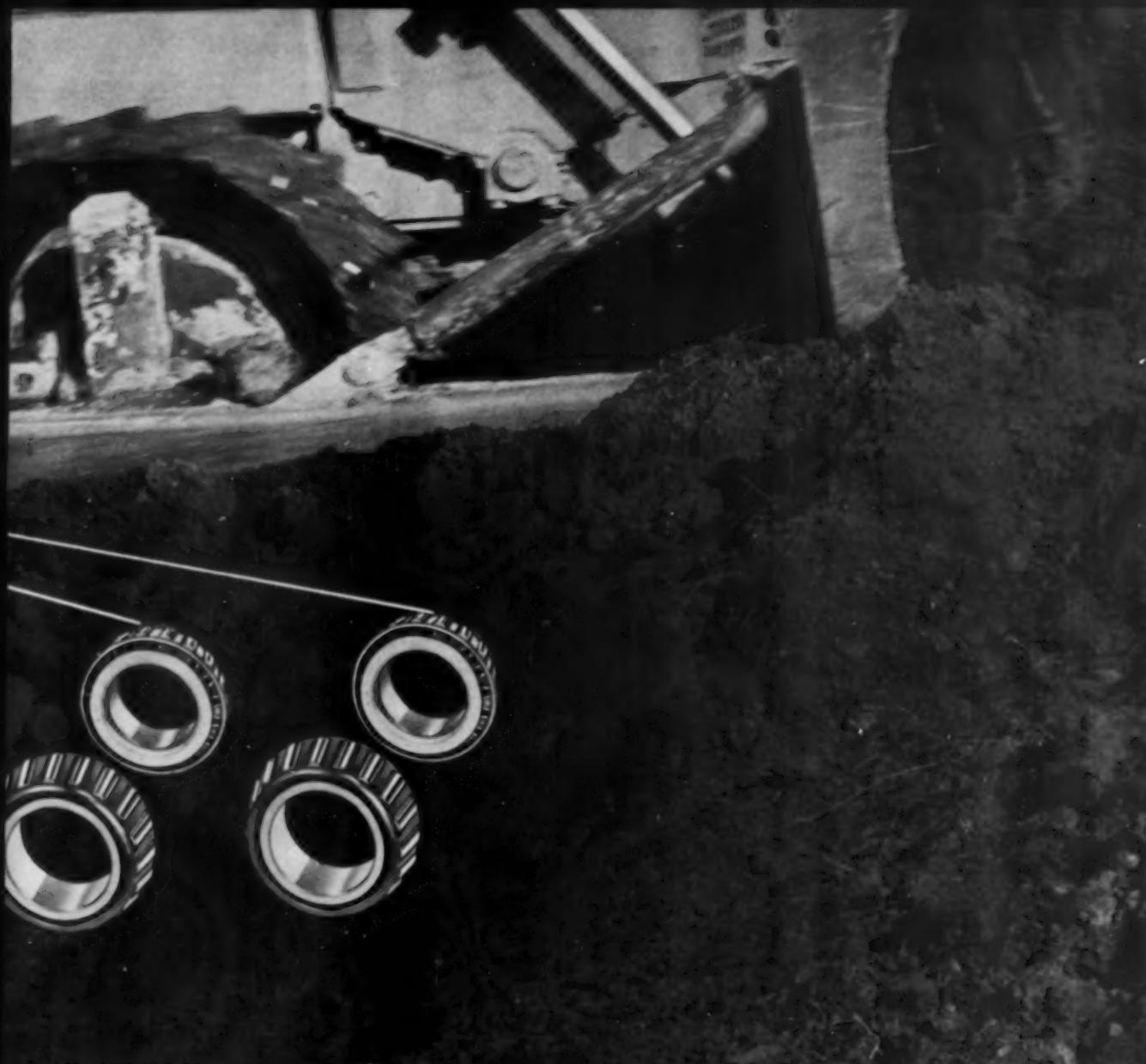
All Allis-Chalmers crawler tractors roll on tapered roller bearing truck wheels. Most others still use bushings.

Anyone who remembers his roller skating days knows the performance advantages of bearings over bushings. The difference between first and also-ran was in the wheel bearing. This friction-reducing

advantage is the reason railroads all over the country have turned to *roller* freight.

The same principle applies to tractors except much more power is being wasted by friction-type plain bushings. It's one of the reasons the 99-hp HD-11, on tapered roller bearings, produces right alongside larger crawler tractors. Can you continue

move ahead with



PER HORSEPOWER

to pay for power that *never* produces—that gets "lost" in old-fashioned bushings?

Your Allis-Chalmers dealer will be glad to discuss this and the many other advantages that keep the HD-11 on the go shift after shift with a minimum of maintenance. Ask about the *toughest track ever built* . . . the *industry's healthiest engine* and *certified permanent lubrication*. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wis.



ALLIS-CHALMERS 
power for a growing world

To order these helpful booklets check the reply card opposite page 34.

Manual on Pipe

Finding Techniques

213. A manual on special pipe finding and leak detecting techniques of interest to utilities, municipalities, oil and gas companies is announced by Fisher Research Laboratory, Inc., 1961 University Ave., Palo Alto, Calif. The manual contains a number of articles on locating buried pipes and cables and detecting and locating fluid leaks in pipe lines.

Clamps for Pipe and Hose and Steel Straps

219. Literature is available from Marman Div., Aerquip Corp., Industrial Sales Div., 11214 Exposition Blvd., Los Angeles, Calif., on clamps to stop leaks on low and high pressure pipe, band clamps for hose, dust, pipe strap hanger and mounting bracket and stainless steel flags for identification purposes. Check the reply card.

A Quick Comparison of Water Meters Helps

274. That is the purpose of the new bulletin describing the newest accomplishments in water meter design and manufacture. With it comes a Condensed Catalog of the Rockwell line. Ask for Bulletin No. W-811 from Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa., or check the card.

385-HP Engine For Standby

Pumps and Generator Sets

372. International 385-hp compact heavy-duty 4-cycle, 6-cylinder engine is well illustrated in literature from International Construction Equipment, International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill. Check the reply card for full specifications.

How to Select and

Specify Water Stops

406. Comprehensive application and installation data on all types and sizes of water stops are covered in valuable Bulletin MRC-473. Address The Gates Rubber Co., 999 South Broadway, Denver 17, Colo., or check number on the card.

Renew Pipe Performance With Cement Mortar Lining

322. Application of the Tato and Spunline process for cement mortar lining of existing pipe lines with a minimum of interruption of service is described, with diagrams, photographs and specifications in Catalog 15-58. Write to Pipe Linings, Div. of American Pipe and Construction Co., P. O. Box 457, Wilmington, Calif., or check the reply card.

Locate Water Leaks

Quicker and Easier

476. An aquaphone that requires no mechanical connection between probe and diaphragm to break or cause of trouble is described fully in literature from Aqua Survey Instrument Co., 824-B North Bend Rd., Cincinnati 24, Ohio.

Measurement of Liquid

Flow Across Weirs

418. The Burgess-Manning Type ML meter is applied to weir boxes for measurement of flow across 90° V-notch weirs. For specifications and installation procedures write Burgess-Manning Co., Penn Instruments Div., 4110 Haverford Ave., Philadelphia 4, Pa.

A Flat Statement

About Round Tanks

434. The title of a new finely illustrated booklet is "Steel Tanks Store Water Best." It gives pictures, essential data, and a fine impression of strength, water-tightness and beauty combined in sturdy structures. For your copy write Steel Plate Fabricators Association, 105 W. Madison St., Chicago 2, Ill., or check our card.

Air Control Valves For

All Types of Pipelines

620. Literature on Crispin Air Valves, which safely control air in lines handling liquids, to maintain efficient operation and prevent expensive failures, is available from Multiplex Manufacturing Company, Dept. C, Berwick, Pa. Write today for your copy of the Crispin Air Valve Catalog, which offers complete information on the full line of dependable Crispin Air Valves.

A New Note in Waterworks Brass Goods

492. The Hays line covers everything from curb stops to tapping machines. Beautifully illustrated catalog is packed with information to help you buy the best. To get your copy write Hays Mfg. Co., Erie, Pa., or check the card.

Manual on the Hersey

Disc Water Meter

521. Illustrations, descriptions and specifications of Hersey Water Meters are covered in Manual from Hersey-Sparkling Meter Company, 250 Elm Street, Dedham, Mass. Size ranges are 2" through 10", Disc, Compound (CI), Fire Service (FM) and Current (T) Meters.

Badger Read-o-Matic Register For Outside Water Meter Reading

534. The Read-o-Matic is simple to install and requires no outside power. Doorbell-type wire carries the pulse from generator in meter to the register on the outside of the building. Check the reply card or write Badger Meter Mfg. Co., 4545 West Brown Deer Road, Milwaukee 23, Wis.

Watertight Concrete for Average Conditions . . .

541. . . can be simply and inexpensively achieved if specifications in Master Builders Bulletin P-4% are followed. This 6-page booklet covers basic requirements for reducing permeability, shrinkage, bleeding and segregation. Write to The Master Builders Co., Cleveland 3, Ohio, or circle number on the card.

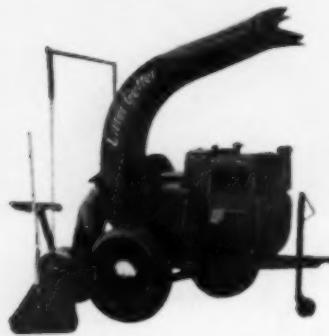
Measure Water Accurately

In Open Ditches and Channels

694. Parshall Measuring Flumes are widely used by Irrigation Companies, Farmers, Cities and Industries. All steel construction assures accuracy within 2%. Available in sizes for 2.1 to 1240.0 cubic feet per second. Catalog B-31-C contains free-flow discharge tables, sizes, capacities and weights. Thompson Pipe & Steel Co., 3025 Larimer Street, Denver 1, Colorado will send you a free copy for the asking.

TARCO "Litter-Getters"

Vacuum-type LEAF and Litter Collectors



suction impeller; replaceable, abrasion resistant, stainless steel liners for suction housing and exhaust duct.

"Litter-Getter" Models: Model L. G., Straight Trailer Mounting, shown here is quickly changed from right to left side pick up. Model L. G., Cross Trailer Mounting, is equipped with a wide, semi-rigid suction snout for windrow leaf collection. Model L. G., Skid Mounting is used on dump truck or stake body truck ahead of the receiving box. Model L. G., Tail Gate Mounting, is used on dump truck tail gate.

See your TARCO Dealer or write us for details.

TARRANT MFG. CO.

28 Jumei Place, Saratoga Springs, N. Y.

Only the Trojan Pipe Puller & Pusher gives you continuous action . . .

No Resetting of Grip!



CUTS COSTS! SAVES TIME-
in installing or renewing pipe under pavement



NEW AIR POWERED Model B

Does all the work for you.
Handles $\frac{1}{4}$ " to 2" pipe.

The Trojan combines pushing and pulling operations in one machine—eliminates all time-killing resetting of grip—keeps pipe continuously moving. Does the job at lower cost—in far less time.

Model A weighs 65 lbs.—requires only 5' trench. One man can easily install the average service. 15 tons of pushing pressure possible.

Model B (either hand or air powered) needs only 5½' trench—has 3 speeds for different soils—is reversible in 30 seconds. Push pipe comes in 30' lengths, assures straight travel.

Write today for full details!

The TROJAN Manufacturing Co.

1114 Race Drive • Troy, Ohio



Hopto's greater digging depth, loading height, reach and swing are not the whole story . . .

MEASURE

Hopto®

**BY THIS KIND OF
WORK CAPACITY**

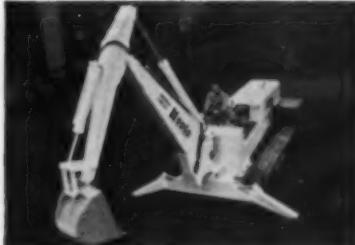
This Model 200 SPR self-propelled wagon ripped through four to eight inches of asphalt and dug out culverts of wood, steel and concrete pipe in digging a four-foot trench ninety feet long. Time required: less than one-fifth of time estimated!

STATE HIGHWAY OFFICIALS watched and timed a HOPTO Hydraulic Excavator knock six and one-half hours from their eight-hour estimate of a culvert replacement project! Handling rubble, boulders, slabs of concrete and pipe was fast and easy with the one-man Hopco.

Listed here are but a few of Hopco's features that paid off in greater work capacity.



MODEL 200-TM Truck mounted, all-hydraulic with triple action system for full power on simultaneous, multiple actions.



MODEL 200-SPC A self-propelled crawler mounted unit with all the features and work capacity of the other 200 Series Models.

SWING:

180° uninterrupted swing gives fast, easy placement of spoil.

REACH:

Hopco's 19' reach offers flexibility for ripping out culverts and rubble.

DIGGING DEPTH:

13' 10" digging depth gives proper depth capacity at good reach.

LOADING HEIGHT:

11' 2" clearance. Evenly distributes heaped loads into highest trucks.

MOBILITY:

One man operates . . . swivels to driving controls.

BUCKET ACTION:

Wrist-action firmly holds rubble, boulders and broken concrete against dipper stick for fast, safe removal and loading.

Brief 'spcs' above are for the Model 200 SPR

Distributors in over 75 principal cities in the United States and Canada

Hopto®

WARNER & SWASEY
BADGER DIVISION • WINONA, MINNESOTA



To order these helpful booklets check the reply card opposite page 34.

SAVE ON PATCHING

with Wylie's new Patch-Mix . . .
lowest cost complete plant ever built

Designed especially for small municipalities. Compact and easy to handle . . . with big plant features such as rotary dryer, pugmill, built-in asphalt tank, volumetric metering system. A self-contained unit on two-wheel trailer. The Wylie Patch-Mix produces all types hot mixes as well as cold mix. Features never before available at such low cost.

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Model PM-310 PATCH-MIX



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BUILD BETTER SEWER LINES



with
WESTON
GASKETS and FORMS
for
SEWER PIPE JOINTS
(a cement joint)

- No jute used—gasket centers spigot.
- Definite space in each joint for cement.
- Form confines cement-grout to lower portion of joint.
- Particularly advantageous in water-bearing trenches.
- Infiltration minimized.

L. A. WESTON CO.

Adams Mass.

Save Your Time on Pipe Pushing and Pulling

517. Continuous-motion machine works all the time to keep pipe moving fast until it is through. Hand or air powered. Write for new folder to The Trojan Mfg. Co., 1112 Race Drive, Troy, Ohio, or use our reply card.

Concrete Pressure Pipe . . .

591. . . and all of its advantages when made by Price Brothers Co. are described, illustrated and its manufacture explained in an attractive 24-page booklet that pipe buyers and layers will appreciate. Just address Price Brothers Co., 1932 E. Monument Ave., Dayton 1, Ohio, or circle the card-number.

Streamlined and Modernized Fire Hydrants

467. Models, dimensions and advantages of the Eddy fire hydrant are covered in bulletin from the Eddy Valve Co., Waterford, N. Y. Check the reply card for complete details.

When the Frost is on the Meter

613. If it is an American frost-bottom meter freezing is no major problem. The replaceable center section breaks out leaving the mechanism undamaged. Bulletin 58 tells the story. Address Buffalo Meter Co., Inc., 2917 Main St., Buffalo 14, N. Y., or circle reply card.

Just Turn on the Rain

674. Rain Bird underground sprinkling system beats depending on the weather to keep your roadides, parks and shrubbery green. Full and interesting details about the system, local dealers, etc. can be had from Rainy Sprinkler Sales Div., Peoria, Ill. Better still, check our card.

Electronic Locators for Water Mains, Services, Valves and Boxes

677. Miniaturized line locator that is encased in a molded glass fiber container and has transistors that have a rated life of 70,000 hours and weighs only four lbs. when completely assembled is described in literature from Wilkinson Products Co., 3067 Chevy Chase Drive, Pasadena 3, Calif. Check the reply card.

CONSTRUCTION EQUIPMENT AND MATERIALS

To Keep You Up-to-Date . . .

22. On tractor loaders, motor graders and tractor shovels, Allis-Chalmers keeps bringing out new literature that is well worth your while. Ask them for it, specifying where your interests lie. Write Allis-Chalmers Mfg. Co., Tractor Group, Box 512, Milwaukee 1, Wis. or circle our card.

Don't Stand There Figuring!

51. Use the new Forney PSI Calculator "slide rule" for concrete products that includes instant conversion data from total load to psi on 17 standard test specimens and masonry units. Pocket size. Free. Address Forney's Inc., Tester Div., Box 310, New Castle, Pa.

Davis Backhoe Has Hydra-Slide Positioning

189. It is possible for one man to move the entire digging assembly along the frame to any of the five positions in less than five minutes. Full details from Massey-Ferguson Industrial Div., 1009 South West St., Wichita, Kans. Check the reply card.

A Fully Rotary Compressor by Jaeger

309. Complete information is available from The Jaeger Machine Co., Columbus 16, Ohio on this 2-stage, oil-cooled rotary compressor. Features include 30% fewer moving parts up to 30% less weight, vibrationless operation and 100% cooler air.

Need Tractor Versatility?

220. Two bulletins tell of various uses—several of them surprising—to which Oliver 550 All-Purpose wheel tractors can be put. Much valuable information is yours for the asking of the Oliver Corp., Ind. Div., 19300 Euclid Ave., Cleveland 17, Ohio, or circle this number and mail card.

The Name is Clark

229. . . The product is a line of Tractor Scrapers, Dozers and Shovels that make your operators happy with powerful heavy-duty equipment, engineered for fast performance on tough jobs. For full details address Clark Equipment Co., Construction Machinery Div., Benton Harbor, Mich., or check our card.

Manual on the Use and Application of Compactors

261. A Manual covering the various types of compaction equipment in use today and including rollers and vibratory compactors is available from The Galion Iron Works & Mfg. Co., Galion, O. Check the reply card for details on the problems encountered in the efficient compaction of various materials, and the correct use of communication equipment available.

Booklet Shows Design of Pre-Engineered Steel Buildings

271. Pre-engineered Butler steel buildings are available in every size, type and design to meet your building needs. In a helpful four color booklet you will find details on several basic designs for community use; answers to your questions on construction and erection; and many illustrations of typical uses. Write to Butler Mfg. Co. 7321 East 13th St., Kansas City, Mo.

Stumped by Stumps?

303. Pow-R-Stump cutter is operated by one man, handles stumps of any width and up to 33 ins. in height and will not damage curbs, driveways or sidewalks. For literature check the reply card or write Vermeer Mfg. Co., Pella, Ia.

Complete Line of Shovels, Draglines, Cranes and Clamshells

361. Bucyrus-Erie crane-excavators in sizes from 36 to 4 cu. yd. capacities are covered in literature from Bucyrus-Erie Co., South Milwaukee, Wis.

Manual on Construction Castings

462. This 168-page Manual covers catch basin inlets and traps, building castings, man-hole covers and steps, flap valves, wheel guards, drainage grates and many other construction and maintenance castings. Check the reply card or write Neenah Foundry Co., Neenah, Wis., for your copy.

Complete Bulletin On Municipal Supplies

473. Everything from leak locators to street signs is listed in the big 100 page bulletin "Municipal Supplies" published by Darley. Hundreds of different items for all city departments are included. Get your copy of Bulletin No. 155 from W. S. Darley & Co., 2814 Washington Blvd., Chicago 12, Ill.

For Better Work All Over Town

525. Put a Bantam in your life. On trenching, excavating, street and highway work this handy versatile crane-excavator obviates using larger equipment in many cases. Saves time and dollars. Get descriptive literature from Schield Bantam Co., 301 Park St., Waverly, Iowa or circle card-number.

Prestressed Concrete in Your Construction Needs

647. Prestressed beams, slabs and girders for bridges are covered in information available from American Steel & Wire, Rockefeller Bldg., Cleveland 13, Ohio. Check the reply card for complete details.

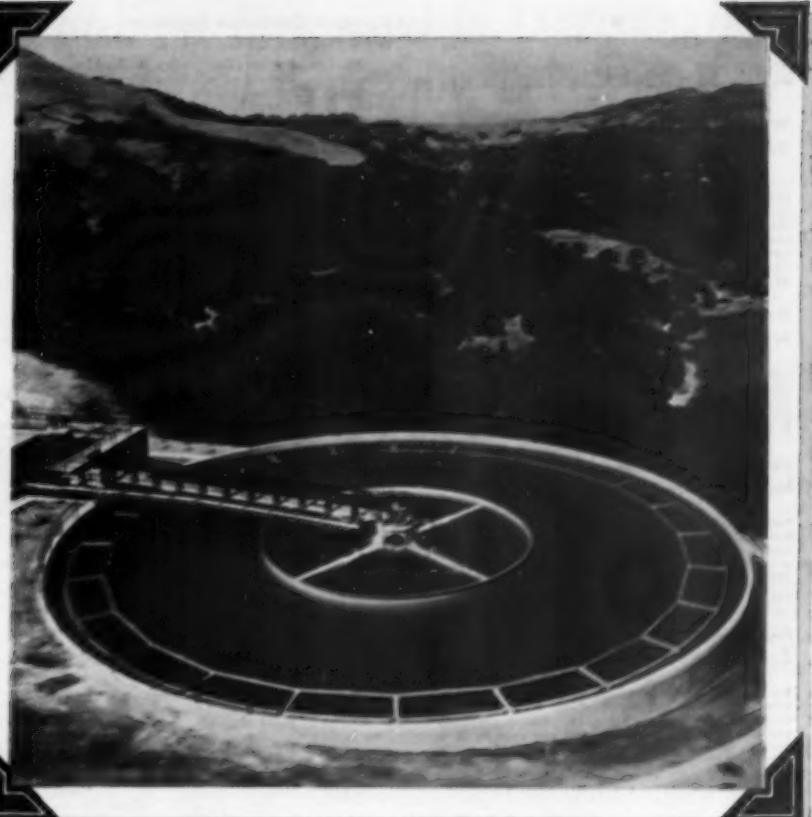
Portable Water Coolers Used on Maintenance and Construction Work

651. Igloo cans and coolers are permanent and range in capacity from 2 to 15 gals. Models and sizes are covered in bulletin available from Igloo Corp., P. O. Box 8227, Memphis 4, Tenn., or by checking the reply card.

Construction Guide For Engineers and Builders

669. A 34-page four sectioned construction guide containing full-page structural drawings that provide basic information on types, grades and applications of fir plywood for engineers and builders has been released by Douglas Fir Plywood Association, Tacoma 2, Wash. Check the reply card for data on floor construction, single and double wall construction and roof construction.

*Installation of this
125 ft. dia. Eimco-Process
Reactor-Clarifier at the
Bon Tempe Plant was under
the direction of
William R. Seeger, General
Manager and Chief Engineer,
Marin Municipal Water
District*



Colorless Water in Colorful California

High on the slopes of Mt. Tamalpais across the bay from San Francisco, the Bon Tempe Plant of Marin Municipal Water District occupies one of the most spectacular settings in California. Surrounded by rich red earth and lush green foliage, the plant is a key element in a system serving the water needs of some 120,000 people.

In the past, when the winter and spring rains washed mud into the storage lakes, the water was both turbid and as colorful as the surroundings . . . a condition unthinkable to District officials. Given the problem, the consulting engineering firm of Kennedy Engineers, San Francisco, came up with an admirable solution—an Eimco-Process Reactor-Clarifier. Now, this economical and deceptively simple mechanism, installed in a 125 ft. dia. concrete tank, combines vertical paddle flocculation with clarification to efficiently remove the seasonal turbidity from a 10 MGD flow. Its

effluent is then given a final polishing by passage through rapid sand filters.

A number of special features help account for this efficiency. One is the method of introducing the influent through openings in hollow, rotating arms. This uniformly distributes the raw water over the surface of the reaction compartment, avoiding short-circuiting. Another feature is the dual-drive, which consists of a flocculation drive and a rake drive mounted together but rotating the paddles and rakes independently. This permits varying the paddle speed to meet influent conditions without disturbing removal efficiencies.

If you have a water treatment problem, may we suggest that you investigate the many advantages of the Eimco-Process Reactor-Clarifier? There's a type and size for every purpose. Write Eimco's Process Engineers Division for full description.

THE EIMCO CORPORATION



8-611E

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BOOTHS 64 and 65

AWWA Meeting — Bal Harbour, Fla. — May 15-20

Process Engineers Division

420 Peninsular Avenue, San Mateo, California

To order these helpful booklets check the reply card opposite page 34.

SEWERAGE AND WASTE TREATMENT

What You Should Know About Trickling Filter Underdrains

36. Specifications for vitrified clay underdrain blocks conforming to ASTM standards, suggestions for layouts and construction of trickling filter floors, dimensions of standard blocks, channel covers, angles and other fittings are available from the Trickling Filter Floor Institute c/o Editor, Public Works, 200 So. Broad St., Ridgewood, N. J. Check the reply card and we will forward your request.

How to Make Better Sewer Pipe Joints

37. How to make a better sewer pipe joint of cement—tight, minimizing root intrusion, better alignment of joint. Permits making joints in water-bearing trenches. General instructions issued by L. A. Weston Co., Dept. P.W., Adams, Mass. Check the reply card.

Catalog on Synchronous Motors and Controls

38. A 27-page Catalog B-7292 on synchronous motors and controls is well illustrated and contains motor selector charts, application data, and formulas for calculating power factor. For a copy write Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa., or check the reply card.

Protective Lining for Concrete Pipe and Structures

39. T-Lock Amer-Plate is a tough, long-lasting acid-resistant vinyl sheet lining for concrete pipe and structures which are exposed to corrosive materials. T-shaped ribs pressed in the sheet are embedded in the concrete as it is poured to lock the lining permanently in place. Get full details from Amercoat Corp., South Gate, Calif., or check the reply card for illustrated folder.

Theory of Controlled Digestion With Floating Cover Tanks

40. In an excellent 40-page booklet, an authoritative discussion of digestion theory and practices, including design, operation and economics is presented by the Pacific Flush Tank Co., Chicago 11, Ill. Complete data are given on the use of floating covers, together with details on tank construction, piping and control chambers.

Modern Methods and Materials For Joining Sewer Pipe

41. In a compilation of reprints and related supplementary material, the Atlas Mineral Products Co., Mertztown, Pa., presents a comprehensive review of all types of sewer jointing materials and methods. You will find this interesting and informative reading.

Turnkey Sewage Treatment Plant

42. Plants for smaller population areas that are furnished and installed on a turnkey basis are covered in literature from Municipal Service Company, 4625 Roanoke Parkway, Kansas City 12, Missouri. Check the reply card for your key to low cost sewage treatment.

Descriptive and Performance Data on Sump and Sewage Pumps

43. Performance tables, selection charts, characteristic curves and architect's and engineer's specifications of Pacific sump and sewage pumps are included in complete catalog from Pacific Pumping Co., 9201 San Leandro St., Oakland 3, Calif., or by checking the reply card.

Separation of Suspended Solids in Water and Sewage Treatment

44. A 24-page bulletin covering the complete line of clarifier and Oxidator[®] mechanisms is available from Process Engineers, Div. of The Elmo Corp., 634 South Fourth West St., Salt Lake City, Utah. Check the reply card for the basic types that cover a full range of tank sizes and load requirements, and special units for unusual conditions.

Stationary Engines For Sewage and Water Treatment Plants

45. Engines that operate on sewage gas, gasoline, butane or natural gas are described in literature from Climax Engine Mfg. Co., Div. of Waukesha Motor Co., Clinton, Iowa. Check the reply card.

Packaged Engineering Data on Packaged Lift Stations

46. Help on sewage pumping problems is available in new bulletins which cover packaged pump stations, pneumatic lift stations and pneumatic ejectors. Write to Tex-Vit Supply Co., Mfg. Div., Mineral Wells, Texas, or check the card.

End Sewage Pumping Unhappiness

47. This new folder shows how others have done it, and why. It can be your road-map to satisfaction through "High and Dry" self-priming sewage pumps. Address The Gorman-Rupp Co., Mansfield, Ohio, or circle our card.

Relief from Sewage Surges

48. . . . is described in this folder about Golden-Anderson surge relief valves with "cushioned closing." Before risking further damage from over-pressure in sewage lines why not get these valuable facts? Address Golden-Anderson Valve Specialty Co., 1232 Ridge Ave., Pittsburgh 33, Pa., or circle our card.

Clean Sewers Cost Less

Then New Ones

49. Here is news on 1960-models sewer-cleaning equipment that can keep money in your municipal pocket. To get more literature on the O'Brien line just write O'Brien Manufacturing Corp., 3632 Northwest Highway, Chicago 46, or check the card.

Small Unit Sewage Treatment For 20 to 5000 People

50. Bulletin 135A describes the Rated-Aeration process, a low cost, odorless, trouble-free sewage treatment process. Check the reply card or write Chicago Pump Co., 622 Diversity Parkway, Chicago 14, Ill.

15,000 Patterns

ON HAND FOR GRAY AND DUCTILE IRON

Construction Castings

WITH LARGE STOCKS MAINTAINED FOR PROMPT SHIPMENT ANYWHERE



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A-M Flat-Base Pipe used in \$120,000,000 expansion of Chicago's O'Hare Field



Utility tunnel designed to withstand 100,000 lb. jet wheel loading

A jet landing strip must necessarily be level—virtually free of dips and cracks. That's why A-M Flat Base Pipe was used for a watermain gallery beneath O'Hare Field's runways as part of its multi-million dollar modernization program—because A-M Concrete Flat Base Pipe has the necessary *rigidity* to resist sagging and tight joints to prevent infiltration. The result is a *dry* utility tunnel—a strong tunnel designed to withstand 100,000 lb. jet wheel loadings with complete safety.

Quickly installed, precast Flat Base Pipe can save as much as 30% in the construction of utility galleries, underpasses, cattle passes and utility manholes. For full details write to:



AMERICAN-MARIETTA COMPANY
CONCRETE PRODUCTS DIVISION

GENERAL OFFICES:
AMERICAN-MARIETTA BUILDING
101 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS, PHONE: WHITEHALL 4-5600

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the Quality Line
IN
WATER
SERVICE
PRODUCTS



One of a
complete line of
Water Service
Products

GENERAL PRODUCTS DIVISION

HAYS MFG. CO.
ERIE, PA.

**Weinman Horizontal
 Non-Clog Centrifugal Pumps**

579. Non-clog pumps for sewage and sludge in municipal plants are covered in literature from the Weinman Pump Mfg. Co., 290 Spruce St., Columbus 8, O. Specifications and dimensions are included.

**Equipment For
 Sewage Disposal Plants**

585. Sewage gas meters, gas regulators, lubricated plug valves and water meters are described in Bulletin C-5200-1, available from Rockwell Mfg. Co., Meter and Valve Div., 400 N. Lexington Ave., Pittsburgh 8, Pa. Check the reply card.

Sewer Cleaning Service

By National Power Rodding

601. N.P.R.C. has mobile-mounted equipment and trained personnel ready at all times for routine sewer cleaning jobs or specialized service. Write National Power Rodding Corp., 1000 South Western Ave., Chicago 12, Ill., or check the reply card for services available from this company.

**Play Safe
 with Automatic Controls**

603. Remote engine and pumping controls of every sort are fully described in a series of bulletins offered by Synchro-Start Products Inc., 8151 N. Ridgeway Ave., Skokie, Ill. Write them or circle the above number on our card.

**Catalog on
 Steel Grating**

605. New ideas in flooring, walkways, stairs, platforms and shelving are covered in Catalog 2527R available from Blaw-Knox Co., Dept. W., Pittsburgh 38, Pa. Check the reply card for information on choice of cross bar and bearing bar designs and spacings.

**Reinforced Concrete Pipe
 For Culverts and Sewers**

672. Elliptical Lo-Hed and Hi-Hed pipes, round pipe and flat base pipe are described fully in literature from American-Marietta Co., Concrete Products Div., 101 East Ontario St., Chicago 11, Ill. Headwall details, discharge curves, hydraulic capacity tables and hydraulic properties are included. Check the reply card.

**Diesel Electric Plants
 Engineered for Your Needs**

666. New 2, 5 and 7.5 kw Diesel plants described and illustrated in 8-page "Diesel Trio" booklet. Fuel economy and quick cold-weather starting are features you will want to know more about. Write Kohler Co., Kohler, Wis., or circle the number on card.

**Full Line of
 Sewer Cleaning Equipment**

681. Everything for rodding sewers, from hand operated equipment to the fully mechanized Sewer-O-Rod. Tools for all types of stoppages are operated by Flexicrome Steel Sewer Rods. Featuring the Truck-Loder which dumps sewer deposits directly into truck, a complete range of Bucket Machines is offered. All equipment is described in 48-page Catalog 55-A. Flexible, Inc., 3786 Durango Ave., Los Angeles 34, Calif.

WEED CONTROL

**How to Cut
 Weed Control Costs**

308. Information on a weed killer that can save hundreds of man-hours of clearing and cutting is available from Diamond Alkali Co., 300 Union Commerce Bldg., Cleveland 14, Ohio. Whether you want to control weeds or brush or both, without damage to crops or ornamentals get this literature today by checking the reply card.

**Don't Fool Around with Weeds
 —Eliminate Them**

599. With Amizol and Amizol combinations, advantages are better kills, lower costs, longer spraying seasons. For full-color brochure that tells the whole story of better weed and vegetation killing, address AMCHEM Products, Inc., Ambler, Pa., or circle card-number.

STREETS AND HIGHWAYS

**Bitumuls Paving Handbook
 Full of Useful Data**

73. The latest edition of the Bitumuls Paving Handbook covers a wealth of practical data on paving methods and materials, road and airport paving specifications and construction details, complete tabular data on asphaltic binder applications and aggregate requirements, condensed Asphalt Institute specifications plus data on Laybahn compounded asphalt for flooring, tennis courts, protective coatings and waterproofing. You can have a copy by checking the reply card. American Bitumuls & Asphalt Co., 320 Market St., San Francisco 20, Calif.

**How to Prepare and Maintain
 Roadways With Calcium Chloride**

65. "The Calcium Chloride Road" is the name of a new 24-page two-color catalog issued by the Columbia-Southern Chemical Corp., 632 Fort Duquesne Blvd., Pittsburgh 22, Pa. Included are sections on dust control, gradation, placing and mixing materials and shaping. General information on spring, summer and fall maintenance is also provided.

**Useful Attachments
 for "Payloader" Tractor Shovels**

95. Increased versatility for Hough "Payloader" tractor shovels is made possible by the various attachments described in literature of the Frank G. Hough Co., 761 Seventh St., Libertyville, Ill. Illustrated and described are rotary "V" and trip-blade snow plows, hydraulic backhoe, back-filler blade, pickup sweeper, scarifier teeth, winches, etc.

**400 Tons an Hour With
 Only 64 Hp . . .**

100. That's just one report on the Koehring "Skoper" which is combining the full-revolving swing of a shovel with the big bucket capacity and versatility of a tractor loader, giving a new concept in speed loading. Cuts costs at every turn. Address Koehring Div., 3026 W. Concordia, Milwaukee 16, Wis.

**Backfill Rammer
 Pucks a Heavy Punch**

150. Powerful Wacker Model GVR 100-C Rammer weighs only 115 pounds so it's in the Bantam-weight class, but it delivers ten powerful blows per second to compact 20 square feet per minute. Durable, compact and easy to operate, it gets into tight corners and meets toughest compaction requirements. Full details from Wacker Corp., Hartford, Wis.

**Compact Wheel Tractor
 Makes Maintenance Jobs Easy**

172. Rugged and powerful yet exceedingly low in cost, the Speedex Model S33 tractor with 9 hp engine will work for you all year around on park and yard maintenance chores. Attachments include gang and rotary mowers, cutter bar, front and rear blades. Check advantages of this versatile machine by writing Speedex Tractor Co., 367 N. Freedom St., Ravana, Ohio.

**Catalog on Tractor-Driven
 Tailgate Spreader**

182. Highway Equipment spreader spreads in the echelon pattern for ice control and the blanket pattern for seal coating. For literature write Highway Equipment Co., Dept. H41 616D Ave. N. W., Cedar Rapids, Iowa.

**Epoxy Resin Adhesives
 for Concrete**

186. Thiokol LP-3/epoxy resin concrete adhesives are especially suited for use in maintaining or repairing concrete structures. Check the reply card or write Thiokol Chemical Corp., Trenton 7, N. Y., for details on testing and application and working properties.

**International Wagner Heavy-Duty
 Loaders and Backhoes**

195. International Wagner loaders and backhoes are matched with International utility tractors and are described in Catalog CR-1076-I available from International Harvester Co., Consumer Relations Dept., 180 N. Michigan Ave., Chicago 1, Ill. Check the reply card.

CLAMPING AHEAD OF PAVING



More and more, clamping bell and spigot joints ahead of paving is becoming standard practice around the country.

When you clamp with the Skinner-Seal Bell Joint Clamp, you get massive malleable iron construction, gaskets sealed by monel band, oversize corrosion resistant bolts.

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To order these helpful booklets check the reply card opposite page 34.

Trenching Equipment Data Conveniently Assembled

212. The entire line of Cleveland trenching and backfilling equipment is now covered in a single bulletin, with material arranged for quick comparison of capacities, specifications and dimensions of all models. Twenty-four action photos graphically illustrate various job applications. Get Bulletin S-120 now for easy review of your trenching equipment needs. Just check the reply card or write to the Cleveland Trencher Co., 20100 St. Clair Ave., Cleveland 17, Ohio.

Illustrated Specifications on Brush and Limb Disposal

222. A new booklet on the modern approach to the brush problem shows how an Asplundh chipper reduces bulky branches and brush trimmings to chip size for mulch or easy removal. Write Asplundh Chipper Company, 501 York Road, Jenkintown, Pa., or use the handy reply card.

How to Solve the Brush Disposal Problem

277. Fitchburg Chippers, engineered to solve the brush disposal problem, reduce troublesome brush and trimmings to tiny, easy-to-dispose-of chips. Several models are available to meet your needs. May be mounted on truck body or on trailer, tractor or jeep. Full details in interesting, profusely illustrated 16 page bulletin. Write Fitchburg Engineers Corp., Fitchburg, Mass.

Why and How To Use Pneumatic Tired Rollers

290. The why and how of pneumatic tired rollers on base and surface courses, sealing completed fills, surface treatments, finished surfaces, hot and cold asphalt, and stabilized soils are covered in Bulletin 10 from Tamco Mfg. Co., San Antonio, Tex. For information on operating conditions and compaction charts check the reply card.

"Work Horse" Power via Wisconsin Engines

233. 3 to 36 hp. heavy duty air cooled engines, ready to go to work when you get them, are described in Bulletin S-249. This bulletin covers power and weight specifications, dimensions and installation data for the entire line. Write Wisconsin Motor Corp., Milwaukee 46, Wis., direct, or check our card.

Eaton 2-Speed Axles For Your Trucks

264. Truck axles that provide easy shift, supply positive lubrication and have a self-contained air brake are available from Eaton Mfg. Co. For complete information on these rugged axles check the reply card or write Eaton Mfg. Co., Cleveland, Ohio.

More Attractive than Crab Grass

279. ... in this new grounds-maintenance booklet on Ford Tractors just issued, 18 action photos in color emphasize the versatility of these tractors in powering mowers, mow-removal and general clean-up operations by all Public Works departments. Write Industrial Sales Div., Ford Motor Co., 2500 E. Maple, Birmingham, Mich., or check the card-number.

Pavement Sealer Protects and Preserves Asphalt Pavement

450. Parking lots, airfield runways, driveways and playground areas are places where Koppers pavement sealer can be used. Check the reply card or write Koppers Co., Inc., Tar Products Div., Pittsburgh 19, Pa., for data on this easy to apply sealer.

Easier Road Widening and Trench Filling

451. Efficient Power-Pack Conveyor equipment and methods for filling trenches and doing curb, shoulder and maintenance work are described in a handsome booklet. Find out how these machines can lighten your labors and lower your costs. Write Power-Pack Conveyor Co., 836 E. 140th St., Cleveland 10, Ohio.

The Trucks You Need for Every Public Works Job

461. Extra life and operating economies are built-in features of every Ford truck model. There's a chassis size and engine for each of your needs, from light utility work to heavy-duty construction jobs. Get latest literature from Ford Motor Co., Truck Div., Dearborn, Mich., by checking the reply card.

Design Manual on Sectional Plate Pipes, Arches and Pipe-Arches

550. Size and weight tables, minimum gages for live load struttured and unstruttured, layout details and plan developments are some of the material covered in this manual. Write American Bridge Div., United States Steel Corp., 525 William Penn Place, Pittsburgh, Pa., or check the reply card today.

For Soil Sampling and Pavement Coring

576. There's an easier way to do both with Acker equipment. Bulletin 26-R describes a kit containing 12 different soil sampling tools. Bulletin 40-R tells about the All-Purpose auger for all types of sub-surface exploration. Bulletin 209-R illustrates the Acker Shear Test Kit for in-place shear tests in soft areas. Name the ones you want. Acker Drill Company, Inc., Box 830, Scranton, Pa., or check our card.

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Design of Concrete

Pavements For City Streets

657. Sections covered in this manual are classes of streets as to traffic, quality of concrete, working stress and safety factor, types of pavement design, design procedure, jointing of municipal pavements and use of distributed steel. Check the reply card or write Portland Cement Association, 33 West Grand Ave., Chicago 10, Ill.

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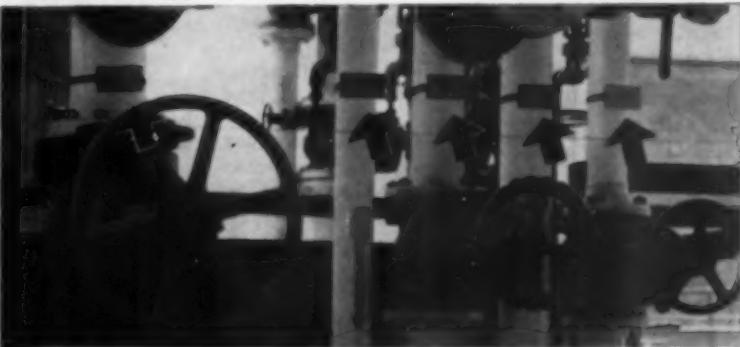


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To order these helpful booklets check the reply card opposite page 34.

Manual on the Use of Calcium Chloride

301. This manual presents the physical and chemical properties of the new pellet-type calcium chloride and its water solutions. Also, gives complete data on shipment, handling and storage. Check the reply card or write The Dow Chemical Co., Midland, Mich., for your copy.

Slurry-Seal Spreader For Surface Sealing

302. The new slurry-seal method with the Tarco spreader gives a thin, even application of asphalt-sand-water slurry and fills and seals cracks and makes skid-proof surfaces. Check the reply card or write Tarrant Mfg. Co., 28 Jumel Place, Saratoga Springs, N. Y., for complete details.

Vacuum Cleaner and Leaf Collector For Cleaner Streets

303. A unit is now available that can be mounted on a right-hand drive jeep or a pick-up truck for picking up gutter trash and leaves. Complete specifications, capacity, operation and installation procedures are covered in a bulletin available from Tarrant Mfg. Co., Saratoga Springs, N. Y.

Construction Methods for Salt Stabilized Roads

309. A comprehensive booklet showing modern methods of salt stabilization is available from the Morton Salt Co., 110 N. Wacker Drive, Chicago 6, Ill. Stabilized secondary roads, base courses and shoulders are discussed and all equipment and construction methods are covered. Just check the reply card for your copy.

Cushman Truckster Delivers Greatest Light Hauling Economy

636. Complete information on the Cushman Truckster is available from Cushman Motors, 900 No. 21st, Lincoln, Nebr. Features are choice of body styles, formed channel chassis, constant mesh transmission and hydraulic brakes, 12-volt lighting system, etc.

Complete Line of Asphalt Patching Mixers

304. Mixers capable of mixing 3 to 20 tons of hot mix per hour are described in literature available from McConaughay Mixers, Inc., Lafayette, Ind. Check the reply card for full information on patching, repairing, resurfacing and sealing.

This Mower Hurries to Work

693. Travels 40 mph in its eagerness to get on the job. Mows at up to 10 mph when there. Has too many desirable features to list here, so learn them all by writing for data and specifications to Topeka Hiway Mower Inc., P. O. Box 720, Topeka, Kans., or check above number on card.

Information

on Trucks for Every Job

432. Literature on the complete IHC truck line is available from International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill. Included is information on basic models, conventional and COE, 4-wheel, 6-wheel and four-wheel-drive. Check the reply card.

STREET LIGHTING AND TRAFFIC CONTROL

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547. with this new-type miniature 2-way transistorized radio system. With it you are never out of touch with jobs or personnel. TELE-PATH Systems can be worn like clothing. No license required for 27 me type. Write for literature to SEISCOR, Box 1590, Tulsa, Okla.

Finest Line of Markers for Fine Line Marking

168. Complete information on truck mounted highway markers, self-propelled line markers, all purpose line markers, and hand-propelled line markers is available from the M-B Corporation, New Holstein, Wis. Photographs and specifications of each type of line marker are included. For more, check the handy reply card.

Lighting Standards for Every Outdoor Lighting Requirement

294. Complete design details, typical installation photos and how Stress-Spun standards are made are covered in this valuable guide. Check the reply card or write to the American Concrete Corp., 5092 North Kimberly Ave., Chicago 30, Ill., for Catalog 400.

For Fast, Accurate, Economical Traffic Line Painting

337. The Mark-Rite Line Marker can stripe one, two or three lines, in one or two colors, with skip lines or solid. Check all features by getting new 12-page brochure from Universal Manufacturing and Sales Co., 434 West Redondo Beach Blvd., Gardena, Calif., or check the card-number.

Be Modern in Your Lighting Standards

423. In this field new designs, new materials, new ideas are emerging fast. To keep abreast you will want these latest folders LS-29 and LS-30 on steel and aluminum pole standards, respectively. Includes data also on brackets, proper heights and other pertinent matters. Address The Union Metal Mfg. Co., 1432 Maple Ave., N.E., Canton 5, Ohio, or check our card-number.

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606. A 20-page booklet points out how to do this most effectively, gives fullest detail. Follow it and more motorists will love you. As first step, ask for Catalog TE-1 of Pfaff & Kendall, 84 Foundry St., Newark 5, N. J., or circle number on our card.

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36. ... and save bruises and bumps. "SAF-PLA" rubberized playgrounds make friends of parents and patrons. Can be applied to blacktop, concrete, etc. Write for it to the children's lawn about "SAF-PLA." Write U. S. Rubber Reclaiming Co., Inc., Box 365, Buffalo 5, N. Y., or check the card.

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486. How to do this is the business of Standard Steel. They invite no-obligation consultation that will include just the information you need to consider modern Marinas that attract boating dollars to your community. Address Standard Steel Products Mfg. Co., Dept. W., 2836 S. 16th St., Milwaukee 15, Wis., or check card number.

REFUSE COLLECTION & DISPOSAL

Where Does It Go From Here?

63. That is the title of new 12-page booklet, D 930, with thorough discussion of garbage disposal by sanitary landfill method. Read the latest report from the experts. Caterpillar Tractor Co., Peoria, Ill., or check card.

Increase Your Refuse Collection Efficiency by 20 Percent

123. New principles and features like continuous loading, pre-crushing of refuse, bigger collections per load, safer operation, lower maintenance, faster collections are all described in new Catalog Section 3a. Write for it to Daybreak Hydraulic Div., Bowling Green, Ohio, or—easier—just circle our card-number.

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Disposal Costs

150. A complete line of refuse disposal systems that include containers, giant containers, compaction bodies and compaction trailers are described in literature from Dempster Brothers, Dept. PW, Knoxville 17, Tenn. Check the reply card for data on these efficient systems.

Load-Packer 600 Points the Way

to the Best in Refuse Collection

188. Bulletins W-200, W-220 and W-221 explain how the Gar Wood Load-Packer gives faster operation, bigger payload, more compaction, a larger hopper and more dependable operation. Write Gar Wood Industries, Inc., Wayne, Mich., or check the reply card for full details.

Literature Describes M-B

Contain-O-Pack System

190. A 6-page catalog describing the M-B Contain-O-Pack, a complete low cost containerized refuse system for private haulers and municipalities is available from M-B Corp., New Holstein, Wis. Check the reply card.

Bulk Refuse Collection

with Super Roto-Can

192. A bulletin describing the bulk refuse system called the City Tank Roto-Can, which provides an unusual flexibility of service and the handling of all types of trash, is available from City Tank Corp., Corona, N. Y. Check the reply card.

Incinerators for the

Disposal of Combustible Wastes

217. Bulletin 179 from the Morse Boiler Inc., New York 17, N. Y. describes fully the basic principles of incineration as to combustion, auxiliary burners, draft and control and elimination of fly ash. Specifications and design of incinerators and hopper doors are included.

General Specifications

for Refuse and Garbage Trailers

231. Two bulletins, one on the Pak-Mor 39 cu. yd. tandem axle trailer unit and the other on the Pak-Mor 32 cu. yd. trailer for use with Model GRD Dempster are available from Pak-Mor Manufacturing Co., Box 14147, San Antonio, Texas. General specifications, power train, operating procedures, maintenance and lubrication and other helpful information are included.

How to Construct

A Sanitary Fill

331. A new 12-page booklet which tells the most efficient method of sanitary fill construction and furnishes complete information on planning and operation is now available from Drott Mfg. Corp., Milwaukee 15, Wis. Get your copy by checking the reply card: you'll find this booklet both interesting and valuable.

Methods and Benefits

of Sanitary Landfill

409. Information on Sanitary landfill methods, organization and necessary equipment with which to carry out the job is available from the Construction Machinery Div., Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Quit Spending

So Much Money

431. ... is the general idea of new booklet on versatile International Drott equipment for specialized refuse disposal. Tells how cities and counties saved big money with proper equipment. It might help you, too. Address Consumer Relations Dept., International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill., or check our card.

Progress in Refuse Removal

495. ... registers a new high mark with the Hobbs Hyd-Pak 60 model. Gives lower loading height, watertight body, 3 "extra" yards all in one ultra-modern, proven piece of equipment. For details on this unit and a pick-up container system, address the Hobbs Hyd-Pak Division, 609 N. Main St., Fort Worth, Texas.

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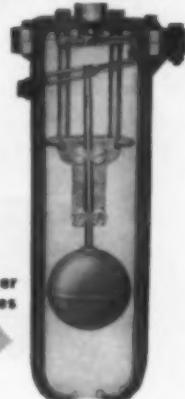
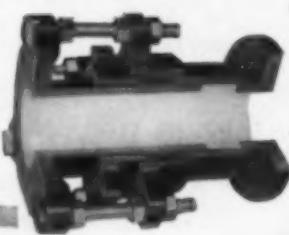
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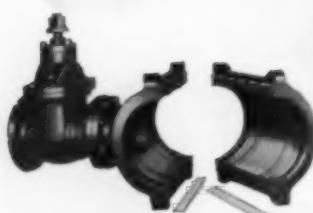
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As a start, it's priced lower* than any other pickup in America. It gives you spectacular gas mileage—up to 30 miles on a single gallon, yet its new 90-horsepower Six is geared to handle a full-sized load.

The Ranchero's solid single-unit construction, its bolted-on front fenders, and other low-cost

replacement parts . . . all mean you'll save on maintenance costs! In its big 6-foot box there is room a-plenty for nearly any pickup job . . . and in its beautifully styled cab there is room for three in stretch-out comfort!

See your Ford Dealer and action-test the Falcon Ranchero—the new kind of pickup that's full-sized for work, over-size in comfort, but only half-size in costs!

*Based on latest available manufacturers' suggested retail delivered prices with comparable standard equipment.

Lowest Priced* PICKUP TRUCK



Single-unit construction . . . It's tighter, quieter, longer lasting. All main underbody structural members are heavily zinc-coated for greater durability . . . protects against rust and corrosion. Front fenders bolt on to cut maintenance costs!

up to **30**
miles per
gallon!

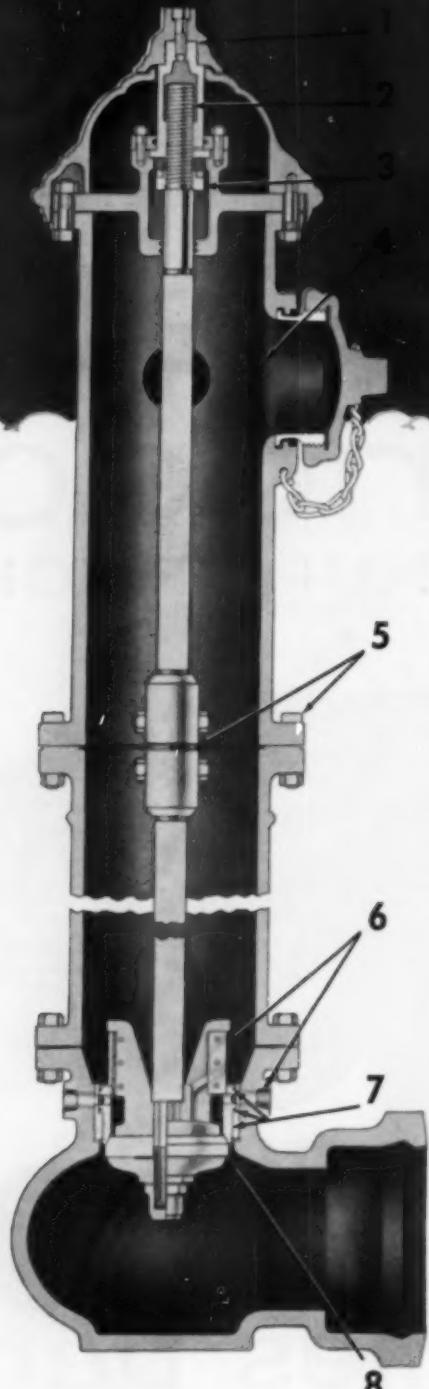
FORD TRUCKS COST LESS

AS
ADVANCED
AS
TOMORROW...

NEW!

**SMITH
MODEL H100
HYDRANT**

proudly joins the time-proven Smith product line. No other hydrant has **ALL** these features:



1. OPERATING NUT: weatherproof and tamperproof.
2. OPERATING MECHANISM: sealed with "O" Rings, operating threads and bearing surfaces permanently lubricated.
3. TRAVEL STOP NUT: prevents bending rod if operating torque is excessive.
4. MAXIMUM DELIVERY: streamlined openings and large standpipe area reduce friction to minimum.
5. SAFETY CONSTRUCTION: if struck forceably, rod coupling and the frangible bolts break cleanly preventing standpipe damage. Groundline flanges permit rotating nozzles to desired position.
6. POSITIVE DRAINAGE: corrosion-proof multiport drain mechanism operates automatically. Drain ports momentarily flushed each time hydrant is operated.
7. VALVE ASSEMBLY: bronze-to-bronze thread engagement and self-sealing "O" Ring Valve construction permits easy removal of internal parts through standpipe using compact lightweight wrench.
8. COMPRESSION VALVE: closes with the pressure — flooding cannot occur under impact.

These and many other important operating and maintenance features are detailed in Bulletin H100 — available on request.

THE A.P. SMITH MFG CO.

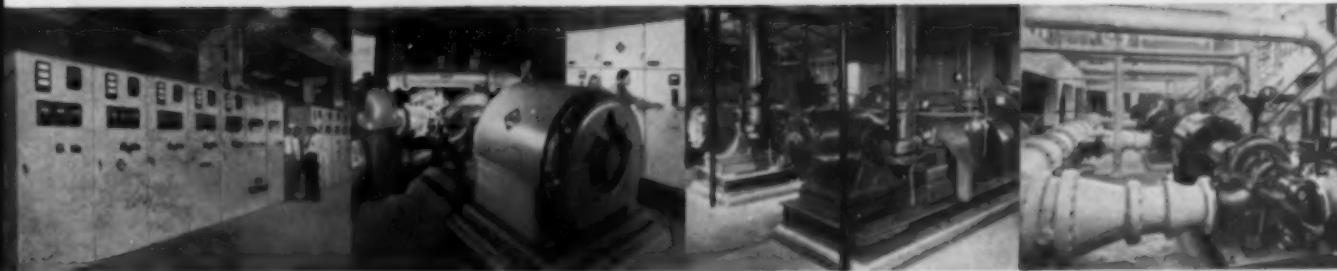
EAST ORANGE

NEW JERSEY

HYDRANTS — VALVES
— SINCE 1896 —

PUBLIC WORKS for May, 1960

ALLIS-CHALMERS

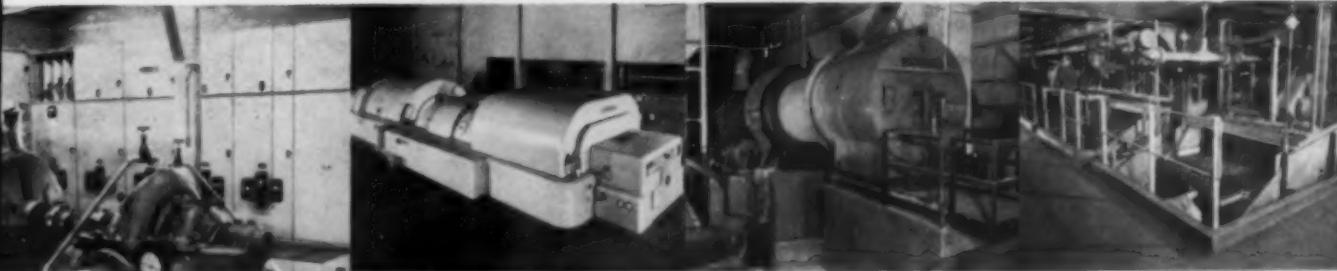


SWITCHGEAR

ELECTRIC MOTORS

COMPRESSORS

WATER WORKS PUMPS

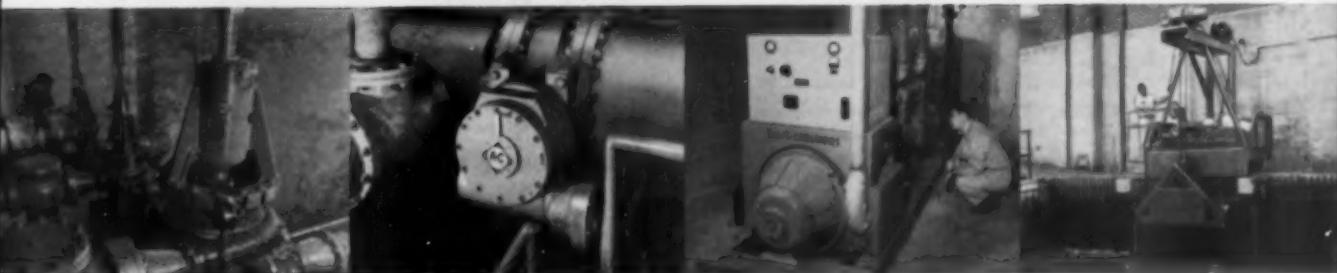


MOTOR CONTROL

STEAM TURBINES

ROTARY DRYERS

VIBRATING SCREENS



SEWAGE PUMPS

VALVES

ENGINE-GENERATOR SETS

TRASH RAKES



TRACTORS

COMPACTOR MILL

DEAERATORS

BLOWERS

Test your public service product "I.Q."

What's our line?

In addition to all the products shown above, there's another dozen* supplied by Allis-Chalmers. Whether you need equipment for sewage plants, water works, municipal power plants, or street and highway maintenance . . . Allis-Chalmers is your most convenient single source.

Municipalities all over the world have modern-

ized, expanded and prospered with expert engineering and application help from Allis-Chalmers. For complete details, call your nearby A-C office, or write Allis-Chalmers, Milwaukee 1, Wis.

*Additional Public Service Products — Transformers, condensers, circuit breakers, voltage regulators, substations, generators, vacuum pumps, sifters, engines, lift trucks, graders, and other earth moving equipment.

A-1311



For on-the-job savings. Seven models of service-utility bodies provide lengths from 79 to 100 inches—available with open or closed cargo areas. Gives you a time-saving workshop on wheels. Six-man Travelette® cab also available.



Emergency Repairs? The Travelette® takes a six-man crew and their tools to any location in any weather. Plenty of room inside, extra curbside door. Six-foot all-steel pickup box.



When dependability is a must. Put your trust in famous R-Line conventional models. Four six-cylinder engines to 501 cu. in. Gasoline or LPG models up to 65,000 lbs. GCW.

FOR EVERY CIVIC NEED,

INTERNATIONAL Trucks are designed to handle any and all community jobs. And they're *built* to conserve public funds!

More than 500 different INTERNATIONAL models by wheelbases assure a truck matched to the job,

low-cost in operation and maintenance. That's because they're available in a wide choice of job-specialized bodies, chassis, transmissions, true-truck engines and components—more than offered by any other truck maker.



For the "Do-Everything" Dept. Pickup models have sand-tight boxes up to 8½-ft. long. Extra strength in frames and springs for extra usefulness and longer life. Four-wheel-drive models also available.



For sand, for salt, for dependability. Proved in all kinds of weather, compact-design dump models have V-8 power as standard. All-wheel-drive available. Highly maneuverable in traffic. Ratings up to 35,000 lbs. GVW.

ECONOMY INCLUDED!

Years of experience building these specialized trucks enables INTERNATIONAL to offer you custom quality . . . and mass-production prices.

To get exceptionally rugged trucks, every kind you need, go to this one dependable source . . . your nearby INTERNATIONAL Dealer or Branch.

INTERNATIONAL® TRUCKS

WORLD'S MOST
COMPLETE LINE

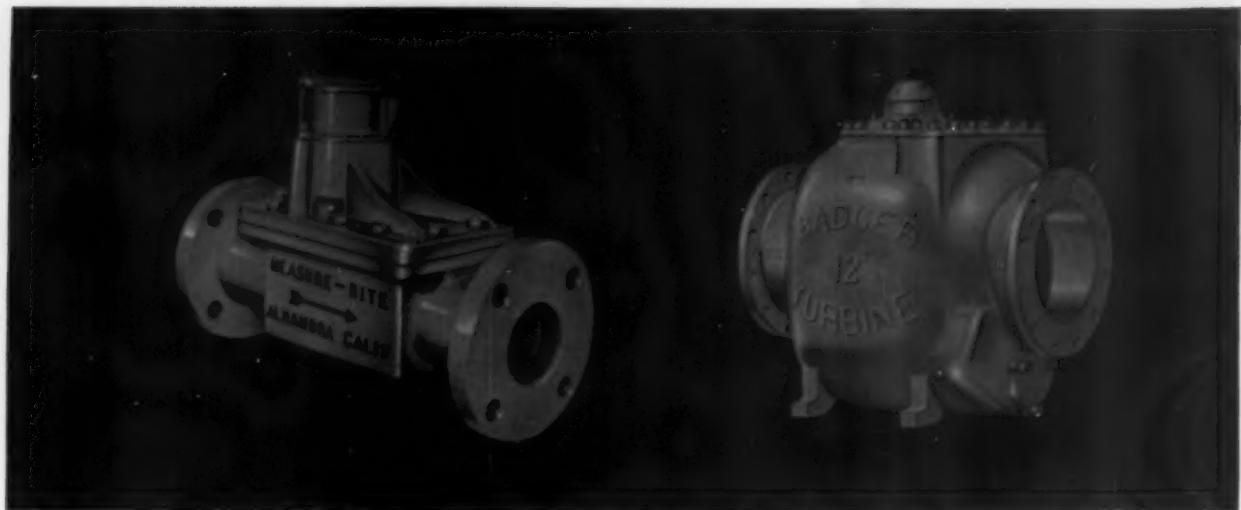


INTERNATIONAL HARVESTER COMPANY, CHICAGO • Motor Trucks • Crawler Tractors • Construction Equipment • McCormick® Farm Equipment and Farmall® Tractors
PUBLIC WORKS for May, 1960



Badger
Read-o-Matic^{*}
the only
self-powered meter-register
you can read outdoors

All Badger models can be equipped with
the Read-o-Matic, for economical meter
reading at conveniently located stations.



**From Badger's "meter-ology" specialists...
a complete line of disc, turbine, compound
and propeller meters for any high-accuracy job**

For over 55 years, Badger has concentrated its research, design, development and production on meters. This "meter-ology" specialization has brought about many of the most important advances in the field.

Badger disc meters, for example, feature the exclusive dovetail thrust roller insert as standard equipment. This insert cuts wear and noise at the water level, and guarantees more accurate registration.

Our propeller meters, too, offer a major design ad-

vantage: they can be mounted even in an inclined position without affecting meter accuracy.

Still big news is the revolutionary Read-o-Matic outdoor meter-register — a completely new product that further proves Badger's "meter-ology" leadership.

Your Badger representative — a "meter-ology" specialist himself — will give you complete details on our whole line of meters, including the popular models shown here. Ask him to call on you soon.

Badger Meter Mfg. Company
MEASURE-RITE, INCORPORATED, SUBSIDIARY
4545 West Brown Deer Road, Milwaukee 23, Wisconsin



*Pat. applied for in U.S.A. and foreign countries

*Safe from
power blackouts!*



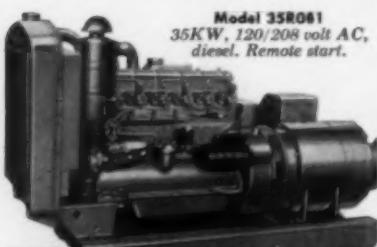
City-County Building communications protected by

KOHLER
ELECTRIC
PLANT

The modern building combining Madison, Wisconsin's City Hall and Dane County Courthouse uses a 35 KW Kohler electric plant for emergency electricity when normal power fails. The Kohler plant insures uninterrupted use of radio systems by city police and county sheriff's office, maintains essential lighting in dispatcher's room, and electric lock and signal system, as well as lighting, for city and county jails.

You can rely on Kohler stand-by plants to take over emergency loads immediately, reliably—including those required for civil defense radio equipment by the new OCDM ruling. Sizes to 100 KW, gasoline and diesel. Write for folder H-4.

KOHLER CO. Established 1873 KOHLER, WIS.



Model 35R061
35KW, 120/208 volt A.C.,
diesel. Remote start.

KOHLER OF KOHLER

Enamelled Iron and Vitreous China Plumbing
Fixtures • Brass Fittings • Electric Plants •
Air-cooled Engines • Precision Controls



LEGAL ASPECTS OF PUBLIC WORKS

MELVIN NORD, Dr. Eng. Sci., LL.B.

De-watering a Building Site

Thomsen-Abbott Construction Co. v. City of Wausau, 100 N. W. 2d 921, a Wisconsin case decided Feb. 2, 1960, was an action by a public building contractor to recover from the city for the extra cost of de-watering a building site, following a change in the concrete footing plans so as to place most of the footings considerably below the ground water table.

The plaintiff, before submitting its bid, carefully investigated the ground water table and found that the specified elevation for the bottom of the footings was six inches below such water table. In making its cost computations preparatory to bidding, it estimated the cost of de-watering the site to a depth of one foot, in order to lay the bottom of the footings dry, at \$1,700. The plaintiff was awarded the contract.

After commencing work and excavating down to level 1157', the plaintiff found muck, humus, and decayed vegetable matter of poor weight-bearing qualities over almost the entire site. The weight-bearing qualities of the material found were much less than 6,000 lbs. per square foot as indicated on the drawings and would not support the building. The footings would undoubtedly have sunk into the muck.

The work was temporarily halted and the city through its architect then authorized and directed the plaintiff in writing to take the footings down to whatever depth necessary to reach sand and gravel which would give 6,000 lbs. per square foot bearing. The plaintiff complied as provided by the contract provision giving the city the right to control the work and require extra services. The plaintiff at that time gave the city notice in writing that it expected to be paid the extra expense of de-watering.

The additional cost of such de-

watering over and above the \$1,700 figure, which the plaintiff had originally estimated it would cost to de-water, if the footings had been poured at the depth shown in the architect's drawings, was \$6,681.41. The plaintiff filed a claim with the city council for this amount, but it was disallowed and he brought this action.

The issue was which of two provisions of the contract controlled. The general provisions of the contract included Article 15 of the A.I.A. General Conditions, which provides for extra payment for extra work, and which says, "Should conditions encountered below the surface of the ground be at variance with the conditions indicated by the drawings and specifications, the contract sum shall be equitably adjusted upon claim by either party made within a reasonable time after the first observance of the conditions." The plaintiff relied on this provision of the contract.

On the other hand, the city relied on another provision of the contract which said, "If it should become necessary to alter the foundation design due to local conditions, we hereby agree to furnish any additional or less concrete as required, complete in place, including necessary excavation, backfill, reinforcing, forming, etc., for the sum of \$74.00 per cubic yard."

The court held for the city. Its decision stated as the reason, that some de-watering was necessarily contemplated in the first place since the bottom of the footings were to be six inches below the water table. Any additional amount of de-watering was held to be included in the provision for \$74.00 per extra cubic yard. The result would have been different if a different type of work were required (instead of just a different amount), i.e., de-watering instead of no de-watering.



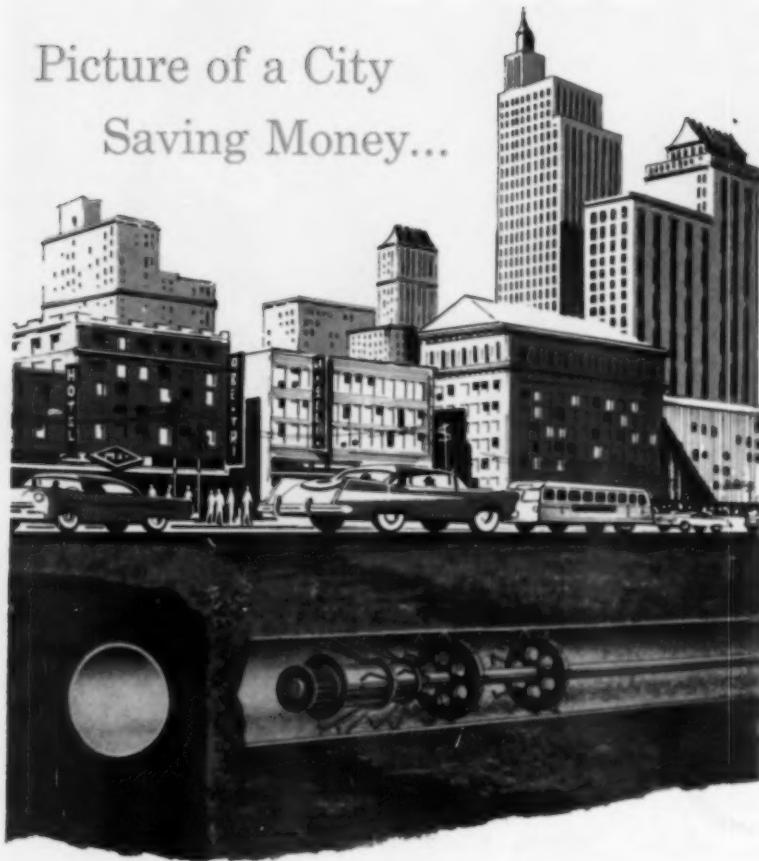
We're surfacing at
Bal Harbour just in time to greet you
at the A.W.W.A. Convention May 15-20.
We'll be looking for you at Booths 117 and 118.

R. D. WOOD COMPANY

Public Ledger Building, Independence Square, Philadelphia 5, Pa.

Manufacturers of Mathews Hydrants and "Sand-Spun" Pipe (centrifugally cast in sand molds)

Picture of a City Saving Money...



Spunline Relines Pipe Lines in-place without removing the pipe

Another city such as Spokane, Dallas, or Los Angeles will soon be enjoying the savings of another rehabilitated pipe line. The flow will increase, the pumping cost will drop and the pipe line will be good as new for at least another quarter of a century.

And traffic will move without interruption or inconvenience to the public.

Spunline® is applicable to pipe lines down to 4" and may be used in cast iron, steel, concrete and wrought iron pipe lines.

Write, wire or phone **PIPE LININGS Inc.**

Subsidiary of American Pipe and Construction Co.

2414 East 223rd Street, Wilmington, California
P.O. Box 457 • Phones: SPruce 5-3273 — TErminus 5-8201
Rail Address, Pacific Electric, Watson, California

Committee to Study Stream Temperature Standards

The Pennsylvania State Department of Health has organized an advisory committee to work with state health department engineers on stream temperature standards to be adopted by the Sanitary Water Board. Among problems the committee is studying are definitions of "normal" and "detrimental" stream temperatures and what can be done to reduce abnormal temperatures. Higher temperatures have become noticeable in the Lehigh, Monongahela and Mahoning and other rivers apparently from such industrial activities as power generating plants, refineries, steel mills, paper mills and tanneries. Committee members selected represent the AWWA, Pennsylvania State Chamber of Commerce, Pennsylvania Fish Commission, Pennsylvania Federation of Sportsmen's Clubs, Izaak Walton League, the steel industry, and the Pennsylvania Sewage and Industrial Wastes Association.

Water Quality Symposium

The Public Health Service will hold a symposium on water quality measurement and instrumentation at the Sanitary Engineering Center at Cincinnati, Ohio, on August 29 to 31, 1960. The symposium will emphasize the establishment, instrumentation and operation of water sampling networks and other related activities in water resources management. It will provide an opportunity to exchange information on objectives, organization and operation of such networks; on the analysis and utilization of data; and on existing needs in the field of water quality measurement. Particular emphasis will be placed on automatic instrumentation. More data are available from The Director, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio.

Rudolfs Memorial Research Conference

Technical sessions will be at Rutgers University, New Brunswick, N. J., June 6 to 8, on the "Principles of Colloidal Behavior and Their Application to Water Sanitation." Basic principles of colloidal chemistry will be presented, followed by a discussion of the application of these principles to water and waste water problems. More information from H. Heukelekian, Chairman, Dept. of Sanitation, at the Rutgers University.



NEW!

**Now, a loader and backhoe worthy
of the Fordson Power Major Diesel**

We'll match the performance, price, productivity, fuel economy, ease of servicing and overall dependability of this new Fordson Power Major package against any similar tractor-loader-backhoe on today's industrial market.

Granted, there's little gamble in this challenge. Fordson diesels long ago won their vote of confidence from tractor users

all over the world. The new Ford 2500 lb. Super-Duty loader and Ford 14' backhoe are basically the same heavy duty units engineered for the Ford Industrial tractor — equipment which has been proved while handling some of the toughest industrial jobs to be found anywhere. Phone your Ford Tractor and Equipment Dealer for a demonstration!

Ford Motor Company



NEW!

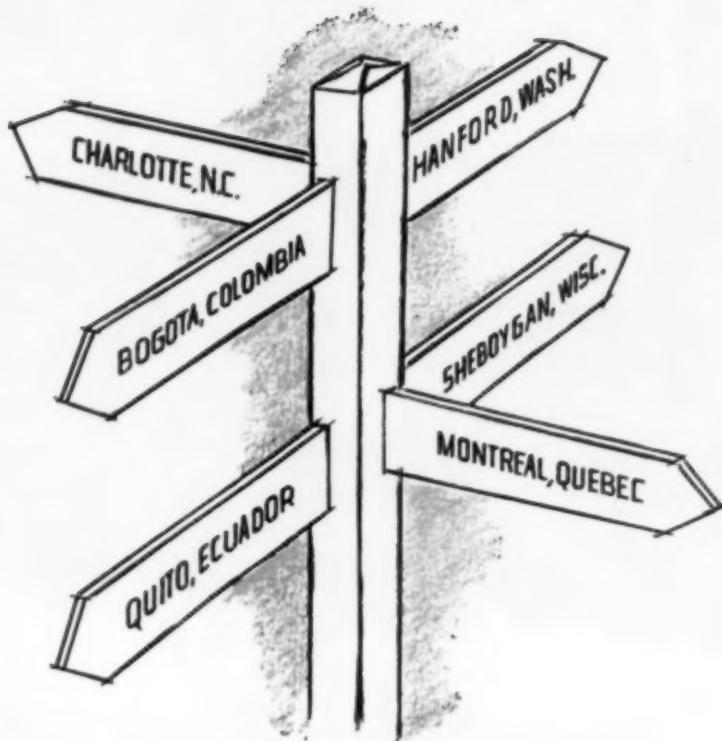
**Fordson's power, weight and economy teamed
with Ford's top producing loader and digger**

The Fordson Power Major is the newest, most powerful version of the world's first mass-produced tractor . . . traces its origin back to the first Fordson of 1917. During those many years of improvements, Fordson has become a byword for steady, dependable tractor power and unmatched fuel economy—a gallon an hour or less under full load, according to many owners. Now, for the first time, you can buy a tractor-matched, Fordson-size loader and backhoe. And what a production team it makes!

The loader has 2500 lbs. rated lift capacity, 5500 lbs. breakaway capacity, 22-degree bucket rollback, 3" below-grade digging and $\frac{3}{8}$ to 1 cu. yd. tread width buckets. The same type rugged subframe and hydraulic system mounts and powers Ford 12' or 14' backhoes. The largest of these, shown above, is in a class by itself and has no competition except for big, specialized rigs. Why not phone your Ford Tractor and Equipment Dealer right now for detailed specifications?

TRACTORS AND EQUIPMENT FOR 101 INDUSTRIAL JOBS

INDUSTRIAL TRACTOR AND EQUIPMENT DEPARTMENT, FORD MOTOR COMPANY, BIRMINGHAM, MICHIGAN



These Places Have One Thing in Common...

This signpost points to just a few of the hundreds of Roberts-equipped water purification installations throughout the United States, Canada and Latin America.

For over 60 years Roberts Filter Manufacturing Company has been complementing the engineering profession in supplying water purification equipment to Municipalities and Industry.

The Roberts nameplate is the assurance of dependable, trouble-free service, quality of materials and pride of workmanship.

the nameplate of dependability...

MECHANICAL EQUIPMENT
BY
ROBERTS FILTER MFG. CO.
DARBY, PENNA.



Trolling on a State Reservoir—Photo by Ted Croner

Reservoirs mirror many things *...and commercial banks are part of the picture*

Sometimes the calm surface reflects recreation. Sometimes it's protection against fire or salvation for parched plant roots. But always the clear, clean shimmer of the reservoir reflects drinking purity and public health.

And here's the way it comes about.

When communities need water supplies nowadays, they very often vote to finance them with revenue bonds. These bonds are offered for sale on the open market by the community authority in charge. They yield interest to buyers out of revenue collected from



the periodic payments of water bills.

By this simple free economy exchange a rural resident's invested savings can help finance a big-city dweller's water supply. And the rural investor earns his interest as the big-city dweller pays his water bill.

But one thing more is important to the whole process of piping water to a community.

It is trusteeship for the bonds issued by the community authority.

This trusteeship is vested in commercial banks. Their trust specialists

see to it that the community water authority meets all obligations to its bondholders.

The end result of this vigilant trusteeship is orderly pay-as-you-go financing for the community, protection for its bondholders and water on tap for each resident.

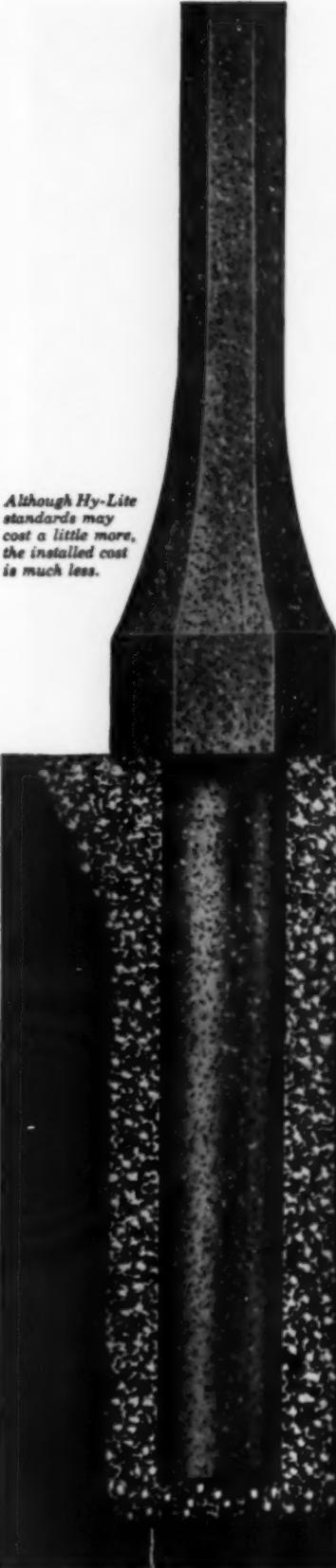
The Chase Manhattan Bank, a leading trustee for revenue bonds in the nation, is always ready to serve the needs of any state, county or community in cooperation with its local bankers.

THE CHASE MANHATTAN BANK

CHARTERED IN 1799

Head Office: New York 15, N. Y.

Member Federal Deposit Insurance Corporation



Although Hy-Lite standards may cost a little more, the installed cost is much less.

- Is street lighting in your planning? If so, you will want to consider *all* costs, not just the price of the lighting standard itself.

With Hy-Lite Stress-Spun standards, the money difference is easily proved by the lower cost of installation, plus the added savings of maintenance-free service.

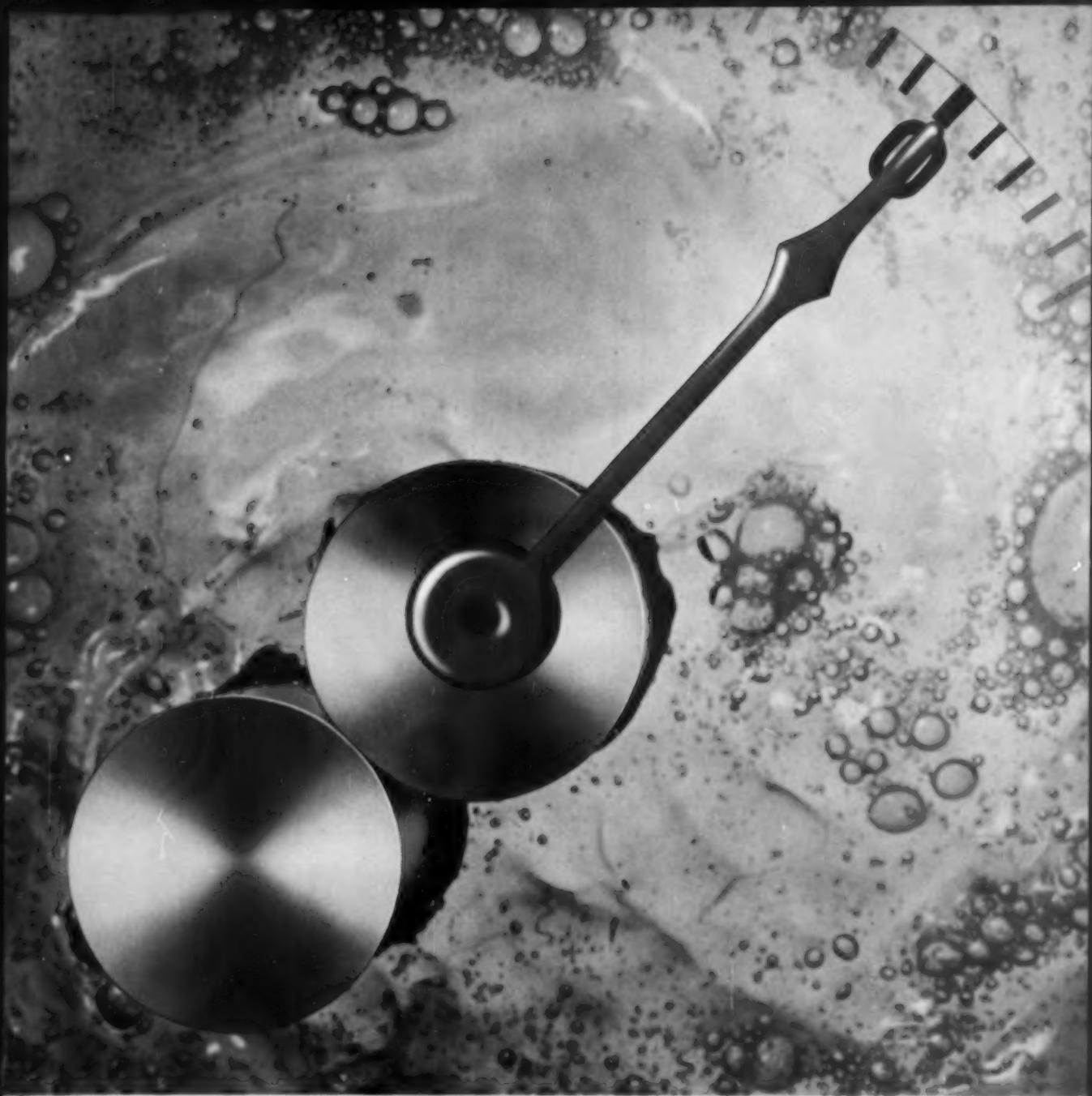
The precast butt foundation design of Hy-Lite standards eliminates all need for expensive, time-consuming "cast in the field" foundationing. Just drill, set, tamp and Hy-Lites are completely installed, ready for wiring.

Add up *all* the money and maintenance saving advantages and we believe you will want to know more about attractive Hy-Lite lighting standards. Write the American Concrete Corporation, 5092 North Kimberly Avenue, Chicago 30, Illinois.

IT'S THE "IN GROUND" COST THAT'S REALLY IMPORTANT

American Concrete

STRESS-SPUN CONCRETE LIGHTING STANDARDS



MAGNETIC ATTRACTION!

the impelling force in
ROCKWELL SEALED REGISTER
WATER METERS



How magnetic attraction drives the register

This simple diagram shows how the driver magnet (shown in hand) revolves around a water-tight compartment at the base of the register. This driver magnet is in the center of the oscillating piston (see below). The sealed compartment around which it revolves encloses the follower magnet. The follower then pushes a crankshaft to transmit every motion of the piston to the sealed gearing and registering mechanism.

The inside story of a better meter design

This simple, accurate design is the answer to the expressed wishes of the water works industry for better measurement at lower costs.

The principal features are (1) a powerful magnetic drive, which eliminates the need for a stuffing box, an exposed intermediate and a driving dog; (2) a hermetically sealed register that forever ends the problems of dirt, water and condensation which make meters hard to read; and (3) measurement by the proven oscillating piston principle for the longest life of retained accuracy.



Here's the answer to your requests for larger sizes of Rockwell sealed register meters

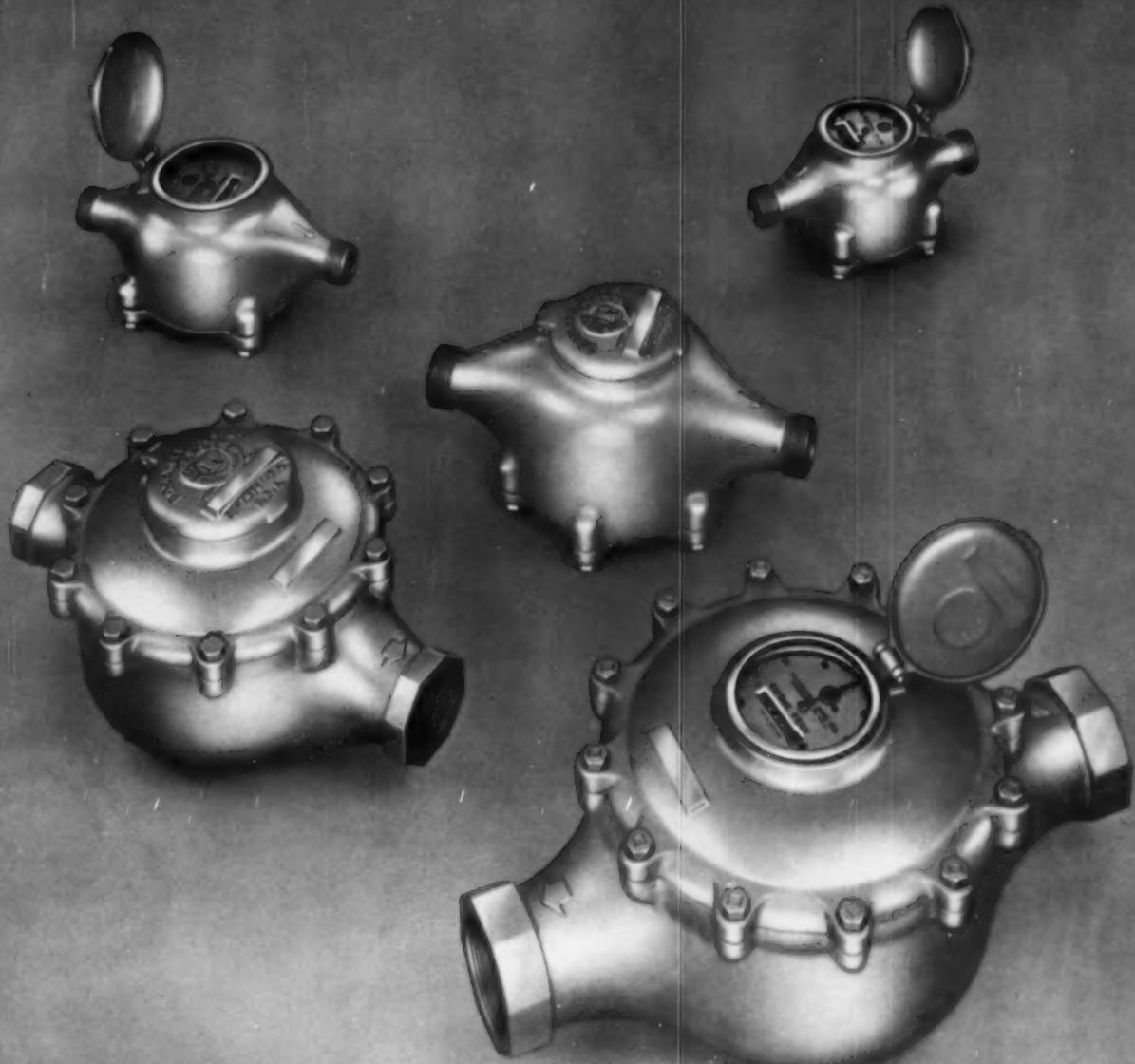
Ever since the Rockwell Sealed Register meter was introduced in the $\frac{5}{8}$ -inch size, users have asked that line be extended to provide the same benefits to the measurement of larger services.

Now, with the introduction of the $1\frac{1}{2}$ -inch and 2-inch sizes, the line is complete. These two sizes differ from the $\frac{5}{8}$ -inch, $\frac{3}{4}$ -inch and 1-inch meters only in that they are made with split cases. All other features—sealed register, magnetic drive, os-

cillating piston, etc., remain the same, although, of course, "beefed-up" dimensionally for the larger volumes involved. Even in these larger sizes, practically friction-free operation provides extreme accuracy on low flows. This advantage, obtainable in no other displacement meter, will in many cases permit the use of Rockwell Sealed Register meters in place of more costly and complicated compound meters. Just try them and see.

$1\frac{1}{2}$ and 2 inch sizes





How you benefit from this Complete line of magnetic meters

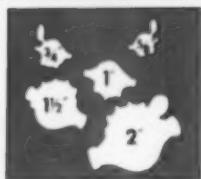
All Rockwell Sealed Register meters in all sizes have the same exclusive magnetic drive principle. All are patterned around the same simple construction. The only differences are in proportions which are directly graduated according to size. This means that for your every service—from $\frac{1}{2}$ -inch all the way up to 2-inch—you can benefit from a meter design that has been proved in thousands of installations to be more accurate, durable and offers lower (and fewer) repair costs.

Take your pick! No matter what size Sealed Register meter you select you will never again need to service a stuffing box—for there are none. You can always read these meters, too, for the hermetically sealed register stays clean, dry and free from condensation.

In this simple design there are only two moving parts that run in water. It's truly the *least vulnerable* meter

ever and one that can be dismantled and assembled with only a wrench.

How much does all this cost you? *No more than you would pay for ordinary meters!* Write Rockwell Manufacturing Company, 400 N. Lexington Avenue, Pittsburgh 8, Pa. In Canada: Rockwell Manufacturing Company of Canada, Ltd., P.O. Box 420, Guelph, Ont.





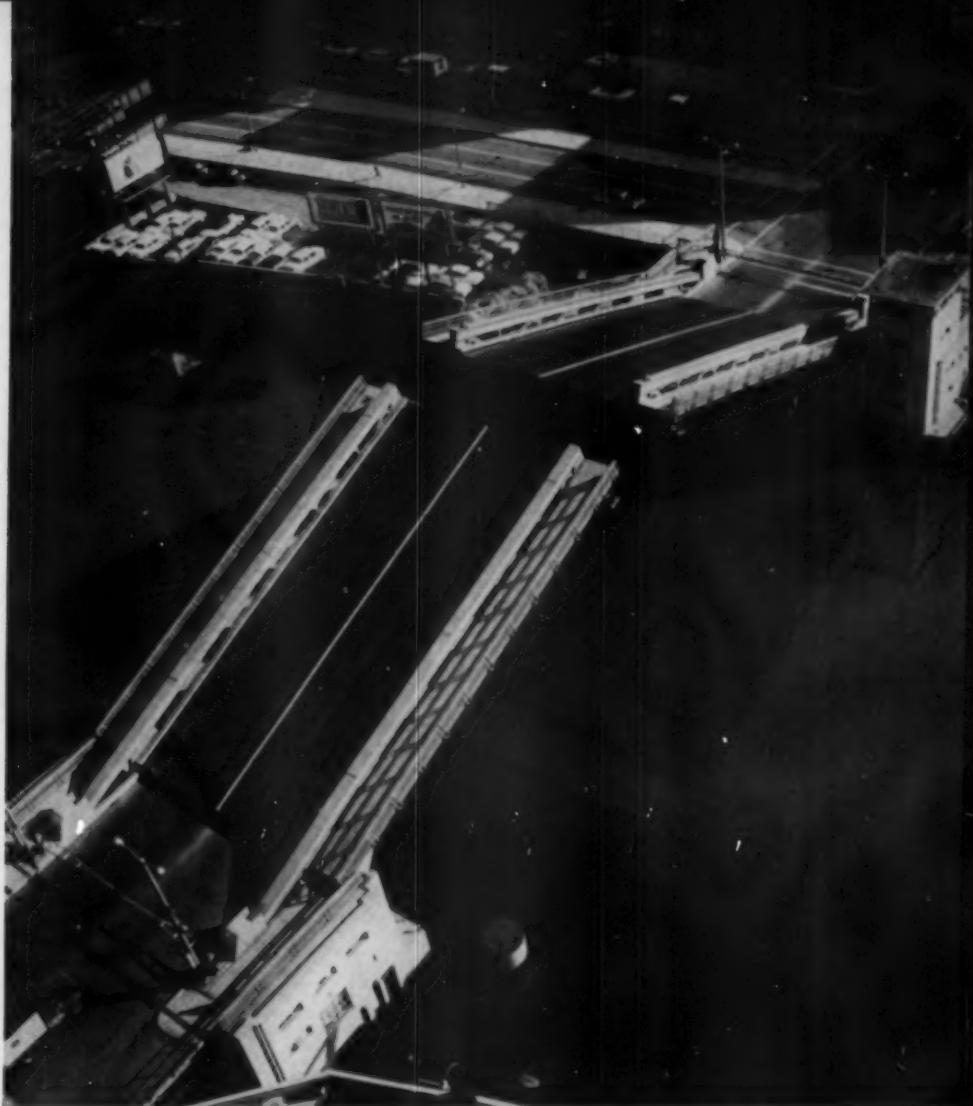
New
Chicago
movable bridge
first with
Westinghouse
a-c static control

YOU CAN BE SURE...IF IT'S **Westinghouse**

COVER PHOTO: View at West Van Buren Street Bridge, Chicago, showing leaf rack, pinion and main drive gearing operated by Westinghouse Bridg-O-Matic control to raise and lower east leaf of bridge.

Double leaf, trunnion bascule bridge opening for Chicago River traffic. One man in operator's room, East Pier, upper right, controls the bridge by means of an all a-c system employing Westinghouse saturable reactor-type controller.

J-64132-2



W. C. Carl, Construction Engineer, Westinghouse (standing), discusses Bridg-O-Matic drive with Stephen J. Michuda, Chief Bridge Engineer, City of Chicago, at right, and his staff (left to right): S. Frayer, Structural Engineer; M. D. Krausman, Assistant Chief Bridge Engineer; and R. H. Keil, Electrical Engineer, Bridge Division.



Stephen J. Michuda; M. B. Trimble, Construction Sales Engineer, Westinghouse; and William G. Divane, President, Divane Brothers Electric Company, Electrical Contractors, discuss main control desk which centralizes operation of leaf and auxiliary drives and selection of east and west incoming service feeders. Instruments on sloped panel indicate leaf position and electrical circuit conditions.



View of switchboard room showing incoming line switching equipment, magnetic control for auxiliary drives, Bridg-O-Matic wound rotor motor control panels and saturable reactor cubicles. Robert E. O'Brien, Chief Electrician, examines panel containing emergency control switching equipment at far end of room.

Westinghouse Bridg-O-Matic Control specified to operate Chicago's West Van Buren Street Bridge

An important factor in the design of the West Van Buren Street movable bridge in Chicago was the selection of the most efficient drive and control system available. Westinghouse Bridg-O-Matic* control was specified after a study of its advantages over other types of control.

The West Van Buren Street Bridge is a double leaf, trunnion bascule bridge across the south branch of the Chicago River and is designed to carry vehicular and pedestrian loads. Each bridge leaf is normally operated by two 100-hp a-c wound rotor induction motors. For emergency operation, a single motor per leaf may be used. During normal operation, the time required to open or close the bridge is approximately 55 seconds. Four electrically operated thruster brakes are provided for holding each leaf in the desired position. Minimum brake shoe lining wear is encountered since the leaves are normally retarded by the motors through the action of the static reactor/Magamp controller to a low speed before the brakes are caused to set.

The normal control of the two operating motors for each leaf, connected for parallel operation, is by

* Trade-Mark

J-94132-3

means of the Bridg-O-Matic control (a-c reactor control system). The speed torque performance of this system provides precision operation under all conditions of leaf load from normal to a 10-lb wind, without the use of any "mechanical" braking, for positive slowdown and reduced speed operation.

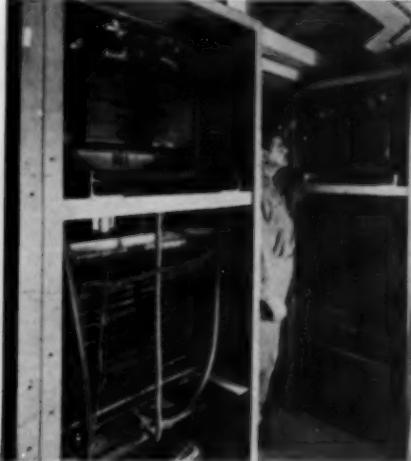
Electric power, supplied by two independent networks, is three phase, four wire, 60 cycle at 208/120 volts, stepped up at the bridge through transformers to 480 volts.

An alternate control system may be selected by moving the control selector switch from "Reactor" to "Off." This provides the conventional reversing wound rotor controller with six power points and a drift point. Either motor may be used. (contd.)

YOU CAN BE SURE...IF IT'S
Westinghouse



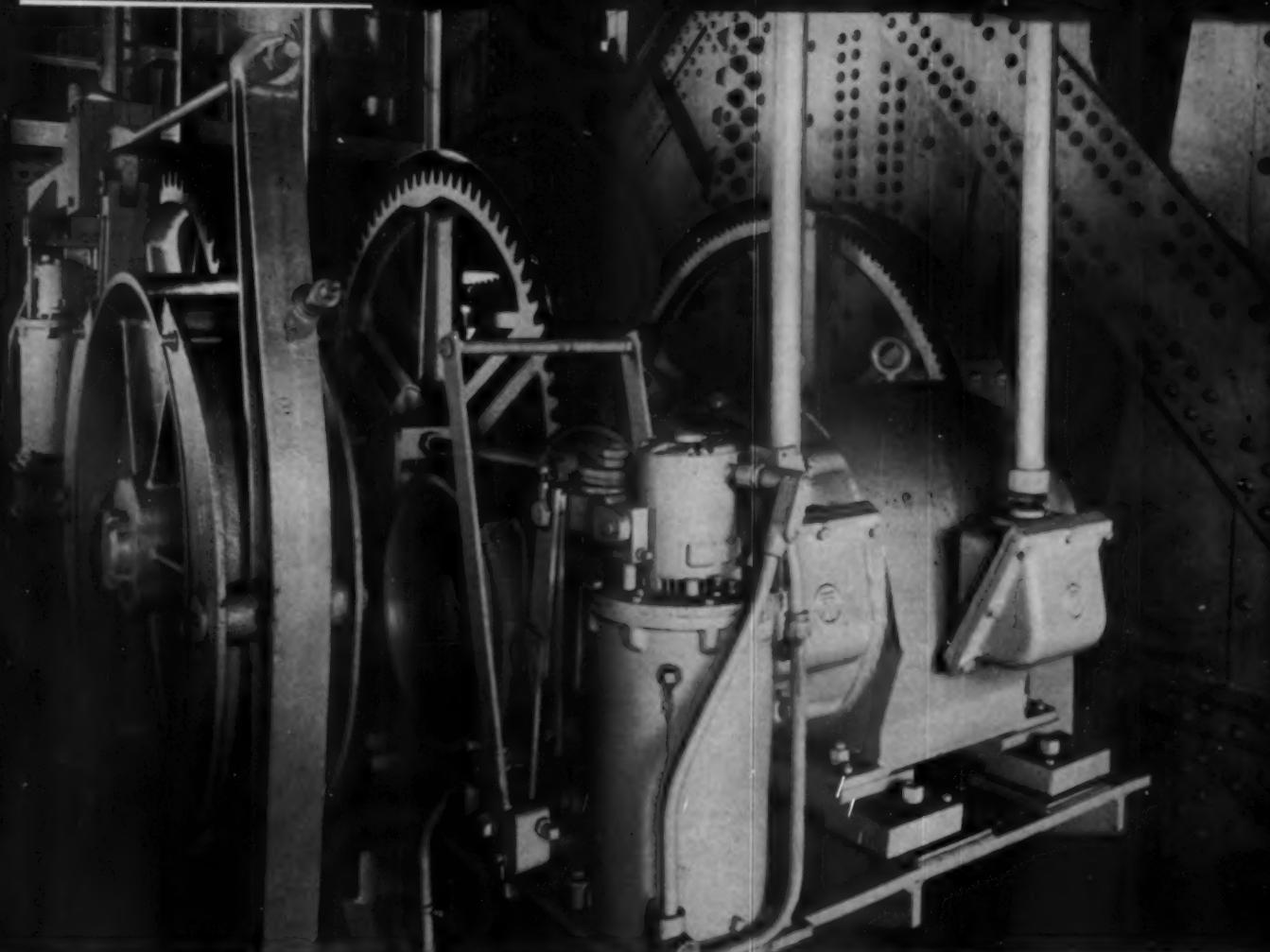
L. A. Johnson, Westinghouse Sales Engineer; E. A. Leske, Electrical Engineer, Divane Brothers Electric Company; and R. H. Keil inspect Westinghouse Magamp control section of bridge switchboard.



Chief Electrician, Robert E. O'Brien, checks cubicles which house Westinghouse primary saturable reactors.



Incoming line cubicle of bridge control (switchboard room, East Pier) is inspected by W. C. Carl; Edward Klausner, Engineer in Charge of Bridge Construction; and R. H. Keil.



Westinghouse Bridg-O-Matic operates Van Buren Street Bridge (contd.)

Interlocks are provided in the control system to prevent operation of leaves until all flashers, traffic lights, gongs and warning horns are operating, traffic gates are down, and bridge centerlocks are withdrawn.

Westinghouse saturable reactor a-c systems offer many possibilities for vertical lift, bascule or swing bridge designs, and other applications such as dam and lock gates, cranes, hoists, etc. For more information call your Westinghouse electrical construction engineer, or write: Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. J-94132-4

OWNER & DESIGNER: City of Chicago, Ill.

Department of Public Works, Bureau of Engineering
Division of Bridges and Viaducts

CONSULTING ENGINEER: Hazelet & Erdal, Louisville, Ky., and
Chicago, Ill.

ELECTRICAL CONTRACTOR: Divane Brothers Electric Company,
Chicago, Ill.

SUPERSTRUCTURE-MACHINERY CONTRACTOR:
Overland Construction Company, Chicago, Ill.

STEEL FABRICATOR: American Bridge Division, United States Steel
Corporation, Pittsburgh, Pa.

View showing one of leaf drives (there are two per leaf), each with Westinghouse 100-hp a-c wound rotor motor and a-c thruster-operated motor and machinery brakes.

John A. Machiels, Bridge Maintenance Mechanist, looks at the 225-kva Westinghouse Inerteen®-filled step-up transformer which provides 480-volt supply for bridge drive motors and auxiliaries. Type DB-50 wall-mounted circuit breaker provides main feeder protection.



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Scum — the problem of ordinary pools — is washed over the coping and out of the pool into properly located skimmer drains. This eliminates hard-to-drain scum gutters above the water line, saves the cost of formed tile gutters and 5" to 10" of excavation and concrete walls.

A few typical water level pool fittings are shown here, but for complete details, plans and pool layouts, send coupon for Manual SP-5, the "authority" on circulation and drainage for all types of pools.

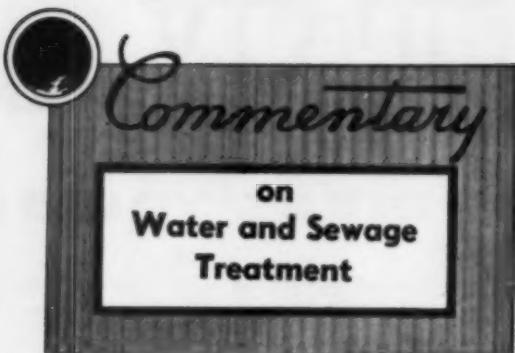
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Removing Excess Turbidity from Surface Supplies

R. S. RANKIN

Consultant, Water and Sewage Treatment

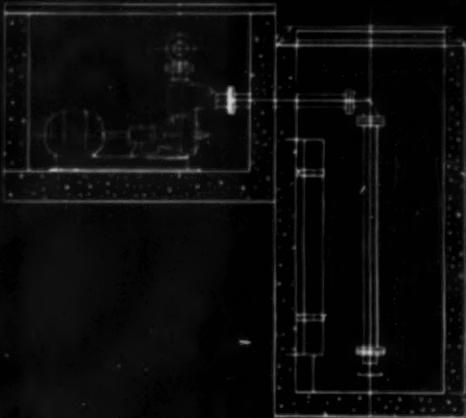
THE REMOVAL of seasonal excess turbidity found in many surface water supplies is economically justified in the chemical savings and in improved operation of the treatment plant. Excess turbidity in this discussion refers to surface supplies having 1000 mg/L or more over a period of several weeks of the year. Treatment becomes increasingly expensive as turbidities exceed 1000 mg/L and operation of upflow units in particular becomes difficult. Facilities for removal of this excess can be included in water treatment plants for a relatively minor percentage increase in cost.

Removal of excessive turbidity ahead of chemical treatment has been practiced for many years, particularly in plants along the Missouri and Mississippi Rivers and some of their tributaries. This operation has come to be known as presedimentation. Facilities have usually been designed for a minimum of 3-hr. detention with a corresponding overflow rate of 4 ft./hr. These have been used on waters having turbidities as high as 20,000 mg/L and exceeding 1000 mg/L as much as 50 percent of the time. The savings in chemical consumption and the uniformity of treatment when excess turbidity has been removed has fully justified presedimentation. Kincaid (1) reporting on the performance of the presedimentation installation at Kansas City, Kansas, on the Kansas River, cites a maximum turbidity in July, 1952, of 11,800 mg/L with an effluent of 250 mg/L. Turbidities exceeding 1000 mg/L occurred 8 months of the year with average effluent turbidity of 320 mg/L and never exceeding 600 mg/L.

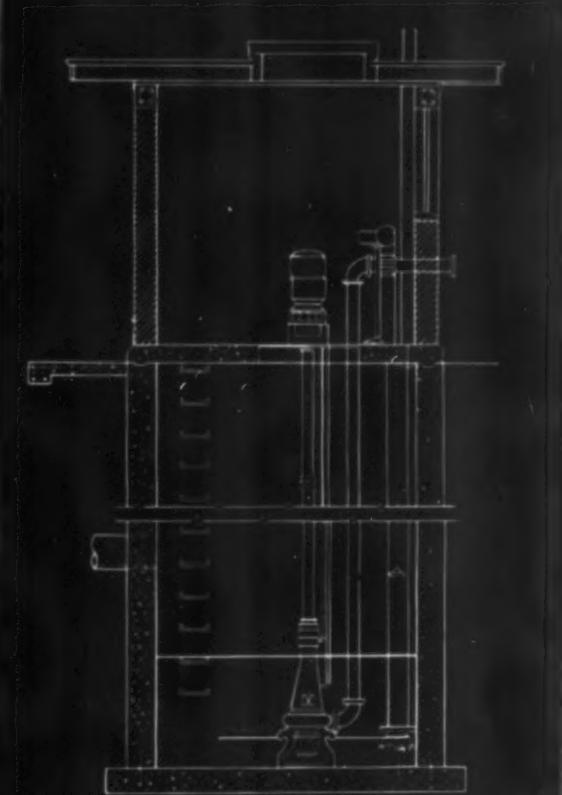
The presedimentation units along the Missouri River, begun in the mid-twenties, have been fully justified. Starting around 1952-1953, conditions began to change as one by one the huge storage reservoirs on the Missouri were placed in operation. It is doubtful whether, in the future, presedimentation on the Missouri will be necessary. For example, Erdel (2) estimates average annual turbidities at Omaha have dropped from 3700 mg/L in 1941 to less than 400 in 1956. This shows what can happen when Federal Agencies engage in a massive program of river regulation. Regulatory works on the main stream benefit those water works using it for supply but commun-

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Typical Gorman-Rupp Horizontal High and Dry Installation



Typical Vertical Wet-Pit Submerged Installation

A glance at the two diagrams above will quickly show simplicity of installation. Further study of equipment costs will add to the proof of savings when you install Gorman-Rupp High-and-Dry Sewage Pumps. These economies are possible through design features which permit self-priming in lifts up to 15 feet, positive action, and nearly complete avoidance of clogging.

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ties on the unregulated tributaries derive little or no benefit and their problems are unchanged. Seasonal floods with accompanying high turbidities continue to affect treatment plant operation. In the plains states many of the supplies need softening, and in these communities the upflow or sludge blanket type of unit is applicable for this purpose; but excessive turbidities will interfere seriously with its operation. Even in conventional treatment plants excess turbidity is undesirable; and when turbidities are in excess of 1000 mg/L preliminary treatment is generally economical.

The design of facilities for removal of turbidity should properly consider many factors such as the maximum concentration expected; the characteristics of the material which create the turbidity, i.e., the ratio of suspended solids to turbidity or coefficient of fineness; and the frequency and duration of the excessive concentrations. With this information and good judgment an overflow rate and period of detention can be selected to reduce the turbidity to a desirable level. The existing installations, designed on the basis of 3 hrs. detention and an overflow rate of 4 to 4.5 ft. per hour (720-810 gal. per day per sq. ft.) were made largely in accordance with the findings of Bull and Darby (3) back in 1928. Several large installations on the Missouri River system have amply justified use of these rates for design during the many months of excessive turbidity occurring on the main streams. However, with increased knowledge of settling characteristics of grit and similar suspensions, these long established rates can be modified.

Maximum turbidities on tributaries, and on many other streams as well, are seldom as severe as those cited, and the design values given can be modified at considerable savings in costs of installation. The duration of excessive turbidities on smaller streams is also much less and the need for high removals is not as great. Between the two extremes of providing no additional facilities for removing excessive turbidities and installing a 3-hour detention basin as generally used, a compromise can be made which will provide the necessary protection at reasonable cost.

To determine the requirements for the compromise, a knowledge of the particular stream is desirable. The coefficient of fineness influences the settling rate, values greater than unity settling faster than values less than unity. Obviously, long time records are most desirable for establishing these and other factors, but lacking these, values for a particular locality can be estimated from tests at times of maximum turbidity. The work of Bull and Darby was done over 35 years ago before the days of flocculators and clarifiers in pretreatment. In reviewing their work, a detention of one hour was generally sufficient even then to reduce the raw water turbidity to less than 1000 mg/L, which concentration now can be handled in pretreatment units with little difficulty. Also much has been done since then to reduce soil erosion although there might be a question whether this is occasionally offset by increased areas under cultivation. This question can be answered only from records of the particular stream under consideration. In any case, facilities which reduce maximum turbidity to under 1000 mg/L should be adequate for most plants now being built.

One advantage of presedimentation in treatment plants using upflow or sludge blanket units on surface supplies is the opportunity to avoid prolonged contact with turbidity of the type which imparts

Concrete Cylinder Pipe For The Hills Of Kentucky

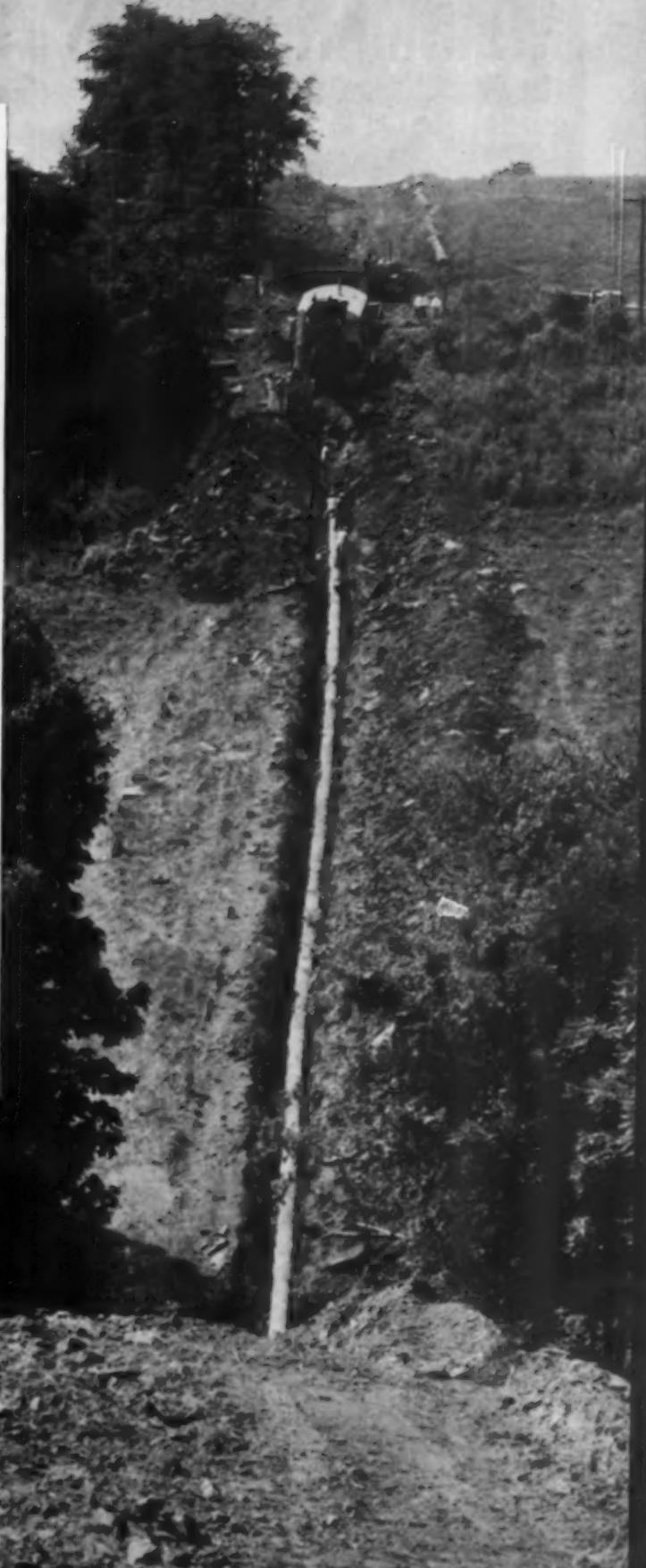
The pressure pipe you see climbing this hillside has a cylinder of steel inside its concrete cover.

This cylinder with its wrapping of high-tensile steel wire combines with concrete to make a pressure pipe of extraordinarily high strength, high capacity and long life.

Because it is the kind of pressure pipe you can bury and forget, it is good for cross country transmission lines like this one, and even better for distribution lines down your city streets.

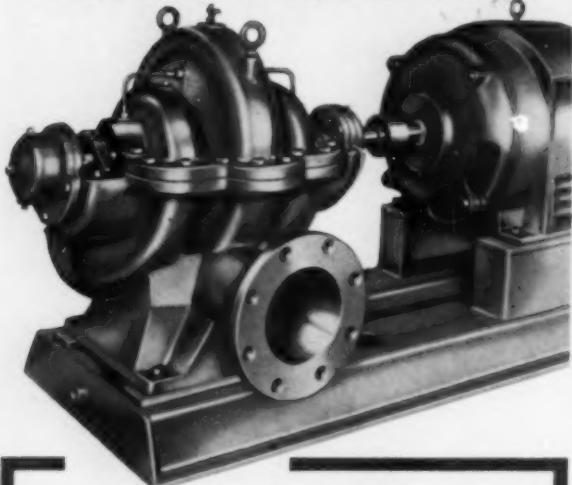
This 43,000-foot line of 18-inch pipe serves the City of Winchester, Ky. and runs, mostly up and down, from the Kentucky River to the treatment plant, and then on to the standpipe in town. Consultants were J. Stephen Watkins, Consulting Engineers, Lexington, Ky. The pipe was manufactured by Price Brothers Company with headquarters plants in Hattiesburg, Miss. and Dayton, Ohio.

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objectionable tastes to the treated water. Even in the conventional treatment plant presedimentation will reduce the time of contact with any taste producing turbidity.

What is suggested is that presedimentation units should provide adequate relief from excessive turbidity in most instances if designed on the basis of 12 to 20 ft. per hour (2160 to 3600 gpd/sq. ft.) overflow rate and 30 to 60 mins. detention. This will require an effective tank depth of around 12 ft. An overflow rate of 12 ft. to 15 ft. per hour, for example, should be adequate to settle 325 mesh (0.04 mm) and coarser material. It is also possible to provide for the addition of chemicals or to return sludge to the presedimentation unit, should increased removals be desirable. Thus, an upflow unit intended for softening a surface water having occasional periods of high turbidity can obtain adequate protection by the addition of another unit the same diameter which will greatly improve its performance during critical periods. For example, an upflow unit to treat 3.0 MGD at an overflow rate of 12 ft. per hour or 1.50 gpm per sq. ft. would be 45 ft. in diameter. A presedimentation unit of the same diameter would give the necessary protection against excessive turbidities. The latter would require sturdy sludge removal equipment and arrangements for bypassing during low turbidity seasons when it would be taken out of service. The same design, of course, can be applied to conventional flocculation-sedimentation units.

These suggestions are intended for existing and new plants for moderate and smaller size communities obtaining water from streams with seasonal turbidities in excess of 1000 mg/L. Obviously, impounding reservoirs are to be preferred for turbidity control, but these are not possible when the supply must be taken directly from the stream. Occasionally even an impounded supply may have excessive turbidities during flood flow. The more uniform the quality of the raw water supply to any treatment plant, the better the product. Removal of excessive turbidity is one way to obtain this uniformity.

References

- 1) Special Design Features of Water Works Facilities For Highly Turbid Waters. R. G. Kincaid, *Proc. ASCE*, Oct. 1953, Separate 309.
- 2) Effects of Missouri River Basin Control on Water Quality. Panel Discussion, Water Quality at Omaha. Joseph F. Erdel, *Jnl. AWWA*, Vol. 50, 1958, Pg. 1196.
- 3) Sedimentation Studies of Turbid American Rivers. A. W. Bull and G. M. Darby, *Jnl. AWWA*, Vol. 19, 1928, Pg. 284.

• • •

Colors for Highway and Airport Pavements

Multi-colored highway and airport pavements may be practical according to the Esso Research and Engineering Company. Synthetic materials (thermo plastics) have been compounded for these and other purposes and during laboratory tests have appeared extremely promising.

Possible uses foreseen include: Airport runways colored to show proper landing areas; interlocking highway arteries and clover leafs made in colors that clearly define correct routes and control speeds; colorful curbing to mark clearly road boundaries.

The method involves compounding plastic materials with aggregate—such as rock or sand—to form about a one-inch thick upper layer or surface of pavement. The colorless plastics can be pigmented

any color. A key feature of the compounds is that they can be mixed and laid using conventional highway equipment without any changes in procedure or machinery.

Test road sections and curbs have been laid down inside the Esso Research Center at Linden, N. J., to determine how the materials would withstand moderate traffic. Later, full-scale field tests on heavily traveled highways and on airport areas will be conducted by Esso Standard Division, Humble Oil and Refining Company.

The plastic materials are derived from oil gases. They include plastics such as the new, highly-versatile polypropylene and polyethylene and polyisobutylene.

Controlling Weeds, Grass and Poison Ivy

High weeds, grass and wild growth along 21 of the approximately 75 miles of public streets in the Village of Scarsdale, N. Y., were cut by tractor and hand mowing. This work, in addition to reducing pollen and improving the appearance of these roadside areas, helps to keep traffic intersections free from visual obstruction caused by the growth of such plants and weeds.

An inspection of public and private property was made for ragweed just prior to the ragweed season last year. On 71 locations, 35 publicly owned and 36 privately owned, ragweed was found. That found on public lands was destroyed. That found on private property resulted in the owners being advised to take necessary action to destroy the plants.

A similar inspection was conducted for poison ivy with growths of this plant being found on 84 locations. The 41 locations on public land were sprayed with ammate while the owners of the 43 locations on private property where poison ivy was found were notified and told to take corrective measures.

Average Prices for Street Work

Average prices based on successful bids during 1958 are reported by the Borough of the Bronx, New York City, with average number of bids per job, as follows: Asphaltic concrete paving mixture, 7 bids, \$17.64 per ton; concrete, Class A, 3 bids, \$29.33 cu. yd.; Class B, 3 bids, \$28.29 per yard, Class C, 11 bids, \$25.18 per yard; new straight concrete curbs, 7 bids, \$2.16 per lin. ft.; R. C. pipe sewer, 30-in., 5 bids, \$22.75 per lf.; 24-in. R. C. pipe, 10 bids, \$18.35 per ft.; VC pipe, 18-in., 10 bids, \$17.89 per lf.; VC pipe, 12-in., 4 bids, \$9.50 per lf.; manholes, 13 bids, \$366.15 each.

City Employee Training Program

Five key employees of Iowa City, Ia., have been enrolled in regular 3-semester courses and will attend classes at the State University of Iowa for 3 hours per week. Attendance will be on city time and the city will pay tuition and expenses. This is the start of a trial program adopted by the City Manager, Peter F. Roan, on a trial basis.

Leaf Removal by Mechanical Loader

During the 1958-59 fiscal year, Scarsdale, N. Y., Reeves Newsom, Village Manager, removed 124 loads of pulverized leaves from village streets through the use of an Egan mechanical leaf loader. The 124 loads amounted to 1,743 cu. yds. pulverized or the equivalent of 5,230 cu. yds. of packed whole leaves.

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The robbery he's stopping is *undercutting* for which American industry pays millions in re-coating and maintenance costs each year. He's stopping this robbery with Koppers' new Bitumastic 11S inhibitive primer, the primer that *ends* undercutting problems.

Bitumastic 11S forms a tight, tough bond with the surface to be protected, preventing the spread of corrosion in the event of damage to the exterior protective coating system. Designed for ap-

plication in severely contaminated industrial and marine atmospheres, this new inhibitive primer also protects cleaned surfaces from "fall-out" before final coatings are applied. Bitumastic 11S solves another difficult coating problem, by thoroughly protecting structural edges and corners where top coatings are extremely vulnerable to damage. A solvent-type primer, Bitumastic 11S is simply applied by brush, and is compatible with almost all types of top coatings.

Two other New Coatings from Koppers Research



Bituplastic No. 33, a new coal tar polymer emulsion coating, is exceptionally resistant to water absorption and offers good adhesion to most substrates. Ideally suited for extreme exposures to heavy industrial atmosphere, Bituplastic No. 33 will not flow or sag at temperatures up to 400 degrees F. This new product gives excellent protection to structural steels, concrete, and other materials subject to attack by corrosive salts and chemical environments. It is applied easily by brush, roller or spray.



Bituplastic No. 44, a mastic coating of troweling consistency, serves as an excellent adhesive and is ideally suited for such uses as adhering cellular glass insulating blocks to the exterior of storage tanks. Bituplastic No. 44 also offers unusual resistance to water absorption, heat and chemical fumes. Another member of the coal tar polymer emulsion coating group, Bituplastic No. 44 is also available on request in a vibrated form, designated as Bituplastic 3S.

Let these New Koppers Coatings work for you

A Koppers specialist will show you how to use these coatings in solving your industrial or marine corrosion problems. From the well-known family of Bitumastic coatings, he'll choose the coating designed for your application. For more information on these new coatings or on our

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**MANUAL FOR
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This new Texas manual is the fourth edition of a book originally published in 1938 and is designed to provide the basic text for use in that state's well-organized training program for water department officials and employees. Aside from covering fundamental information on water sources, pumping, treatment, analysis and distribution, the book presents topics of interest to water department management and consulting engineers. There are chapters on maintenance and capital improvement finance, water rate structures, public relations and water resource management. It has some aspects of a handbook with chapters on general chemistry, water works arithmetic, swimming pool operation, instrumentation and safety and emergency operation. The appendices contain the Public Health Service Drinking Water Standards with the 1956 amendment, the PHS Manual of Water Sanitation Practice, the Texas design standards for water systems, a listing of AWWA standard specifications, and a 5-page unit conversion table. All chapters include review questions to aid those using the volume as a training text. Much of the new material is in the water works management and reference data categories, although it is apparent that the entire book is reorganized and rewritten. Its size, for example, is 879 pages compared with the 583 pages in the third edition. It now contains 32 chapters and three appendices, authored by 35 individuals, of which most are municipal water department employees or engineers and scientists in related fields. The editor is Professor J. H. Sorrels of the Civil Engineering Department of Texas A. & M. College. This edition is dedicated to the late Vic Ehlers, Texas State Sanitary Engineer from 1915 to 1959 and the instigator of the state's water and sewage works operator training program. While the book is prepared primarily for Texas operators, as with the previous Texas manuals it contains a wealth of carefully selected information seldom accum-

ulated in a single publication. For that reason it will be found of value in many a water department regardless of its geographical location. The price is \$9 to non-members of the Texas Water and Sewage Works Association and \$8.50 to members. Copies may be obtained from the association, the address of which is 2022 Indian Trail, Austin 3, Texas.

**THE HIGHWAY AND
 THE LANDSCAPE**

This book consists of a series of contributions by highway engineers and architects specializing in other than roadway surfaces and bridges. The subjects vary from a discussion of "the complete highway" to suggested plant materials for roadsides. "Fitting the highway to the landscape," and "preserving the scenic qualities of the roadside" are sections covering one phase of the approach. Other sections discuss the effect of highways on property values and zoning as a means of roadside protection. Edited by W. Brewster Snow, Professor of Civil and Sanitary Engineering, Rutgers University; 223 pages; Rutgers University Press, New Brunswick, N. J.; \$5.

**CURVE
 SURVEYING**

This is a very complete and helpful handbook for highway (and railway) engineers which deals with the various methods and calculations for setting out circular arcs with chain, tape and theodolite; also the location of compound and reverse curves. The amount of cant required on a curve is discussed and the cubic parabola, clothoid and lemniscate described. There are four and seven-place figure tables for use with the clothoid and lemniscate. By R. B. M. Jenkins; the Cleaver-Hume Press Ltd., 31 Wright's Lane, London W8, England; 182 pages; 35 shillings.

**TRAFFIC
 ENGINEER**

This is one of a series of "American Occupations Monographs." It defines the field of endeavor; tells of the number of engineers engaged, with salaries and other data, including personal and technical qualifications; reports on working conditions; lists educational requirements and courses of study offered; discusses opportunities; and outlines methods of getting jobs. This is a pocket size text, offset, of about 30 pages. The price is \$1; the author is Thomas J. Seburn of the Yale Bureau of Highway Traffic, Research Publishing Co., Inc., Box 425, Boston 1, Mass.



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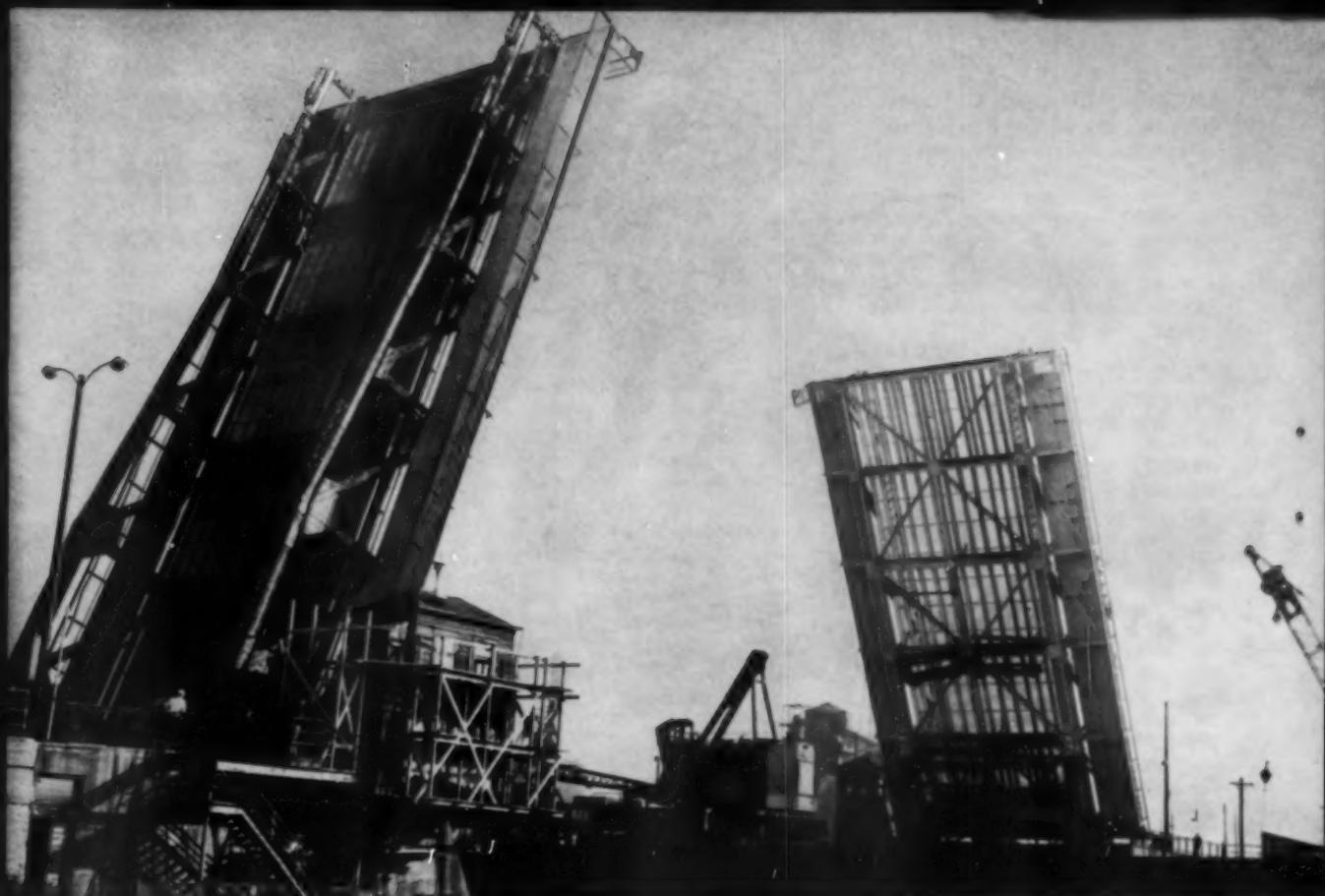
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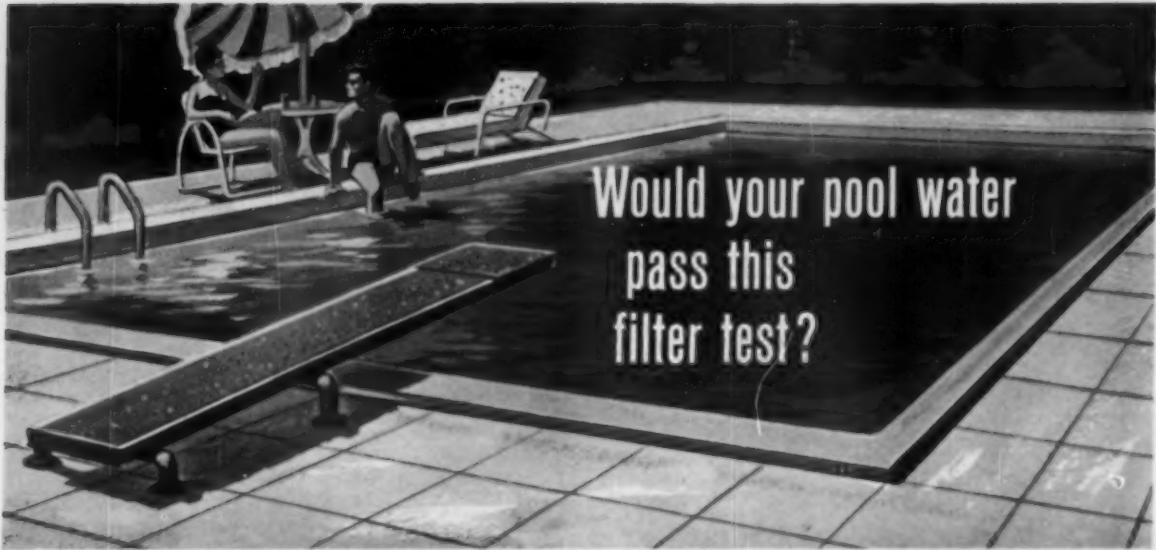
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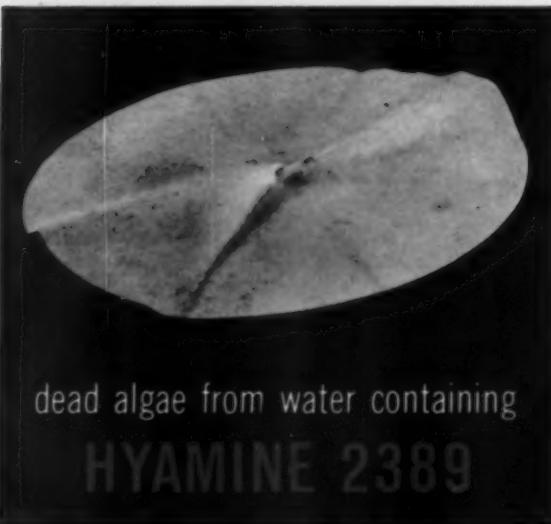
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Division of
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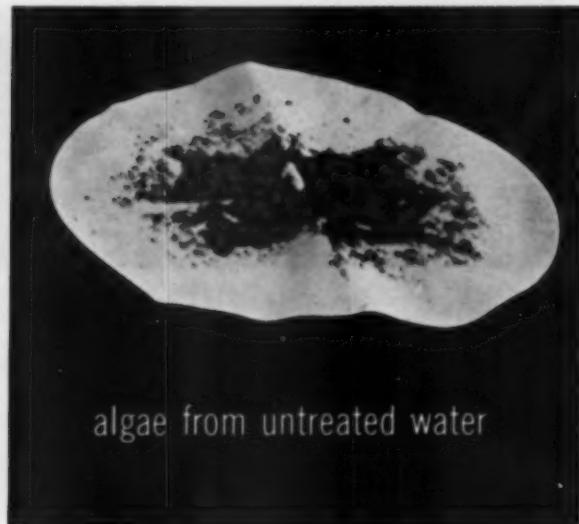




Would your pool water
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dead algae from water containing
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These filter papers show the remarkable results of a controlled laboratory test on algae growth. Just three ounces of untreated water, when poured through the filter paper on the right, produced the amount of algae shown. The same amount of water treated with algae-killing HYAMINE 2389, poured through the filter paper above, left only slight evidence of dead algae. Proof positive that regular treatments of

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ROHM & HAAS COMPANY
SANITARY CHEMICALS DIV.
WASHINGTON SQUARE, PHILA. 5, PA.

Please send me information on HYAMINE 2389 for swimming pools... and a list of algicide brands based on HYAMINE 2389.

NAME..... TITLE.....

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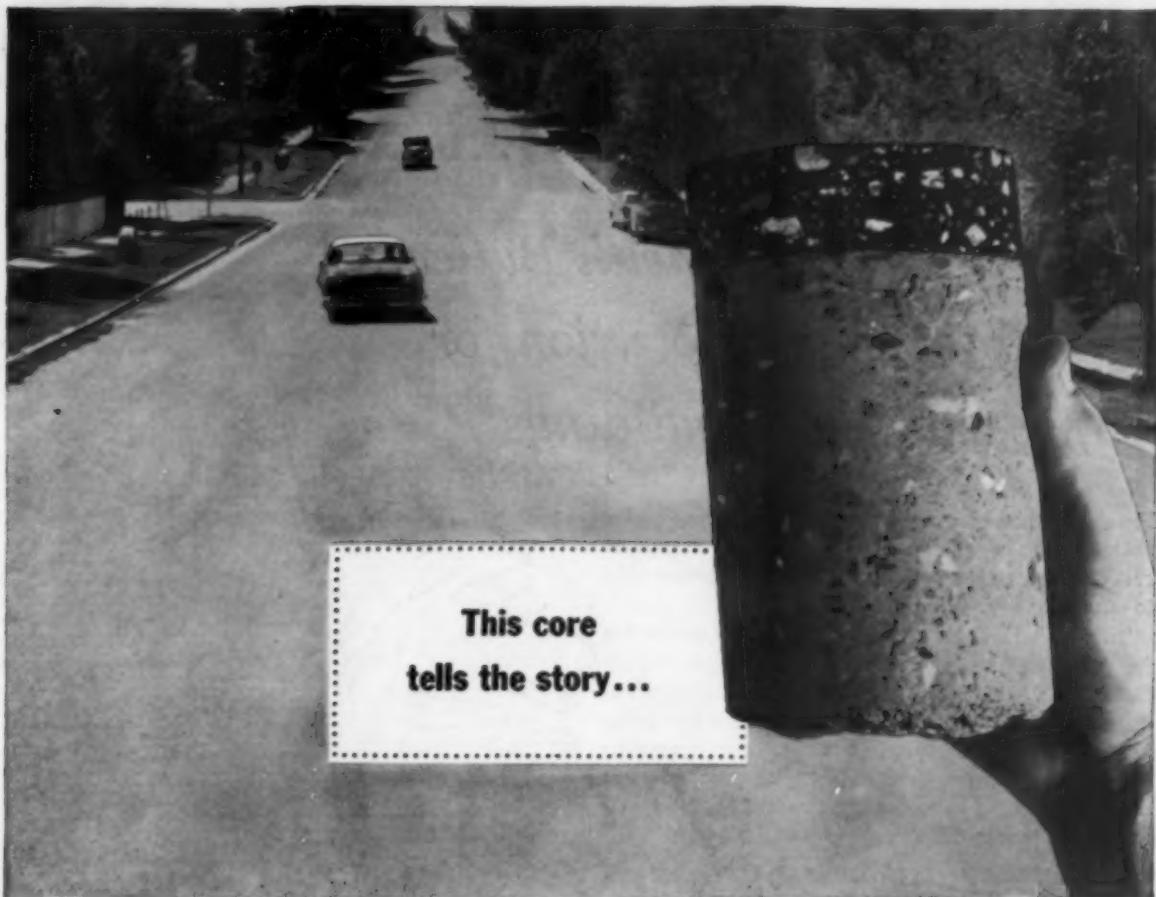


Chemicals for Industry

**ROHM & HAAS
COMPANY**

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

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This core
tells the story...

Strength more than doubled! In October of 1959, this core registered a strength of 2,200 psi. In 1952 samples from these streets had a 7-day strength of 936 psi. Ten per cent portland cement was used.

In just 7 years, strength of soil-cement streets in Gillette, Wyoming, increased 135%

...soil-cement pavement grows stronger year by year!

Core test proves conclusively: soil-cement outlasts any other low-cost paving material! Soil-cement is stronger inch for inch than any other paving material, short of concrete. Yet, in most cases, 75% of the materials are free.

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PORLAND CEMENT ASSOCIATION

A national organization to improve and extend the uses of portland cement and concrete

**MODERN
soil-cement**

A GUARANTEED ROOF OVER YOUR HEAD

*New...and only with Butler...
full 20-year roof protection for
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For your new building, take advantage of the wide, clear spans of Butler rigid frames . . . the beautiful new Butler-Tone™ baked-on color finishes for wall and roof panels . . . your choice of the finest factory-insulated or field-insulated exterior wall panels . . . the fast, trouble-free construction . . . and the dependable, talented services of your local Butler Builder.

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BELZONI, MISSISSIPPI

Sanitary landfill rids city of smoke, odor, insects and rats "as big as rabbits." Reclaims land for future port facilities and park.



A sanitary landfill operation eliminates the need for sorting refuse. It costs less than incineration. And best of all, Caterpillar equipment does a double job. For example, it can be used for excavation, fill, snow removal, street repair, etc.

955 Traxcavator disposes of refuse. Also used for loading slag, stockpiling gravel, sewerage construction, and many more jobs.

In 1957 Belzoni (pop. 4600) embarked on a 10-year sanitary landfill program to get a cleaner city and to convert wasted land into useful property. Complaints from residents are a thing of the past. An open dump $\frac{3}{4}$ mile east of town has been replaced with a fill area 1500' x 600' along the Yazoo River.

Refuse is dumped, spread, compacted and covered nightly with 6" of earth. After the accumulation reaches maximum grade, it is covered with 2' to 3' of soil. A 955 Traxcavator is the key to the operation's success.

It is a 1 $\frac{1}{2}$ cu. yd., 70 HP machine designed for rapid cycle time, easy operation and versatility. A fast hydraulic system cuts cycle time and increases maneuverability even in close quarters. Operator visibility is excellent. Tractor controls are conveniently located for handling ease. Bucket controls are at the right arm rest . . . spaced for easy operation with one hand.

The reliable Caterpillar Diesel Engine has a fuel-saving injection system and ability for hard lugging. Lifetime lubricated rollers need no servicing until rebuilding. The exclusive Caterpillar oil clutch provides up to 2000 hours without adjustment. This is equal to

about 12 months of adjustment-free operation. With hydraulic track adjusters, an ordinary grease gun is all that's necessary to adjust tracks.

And there's a full line of quick-change attachments for the 955 . . . special buckets, bulldozers, forks, the exclusive side-dump bucket. Wherever you put it, the 955 does the job at top efficiency.

Your local Caterpillar Dealer can give you the complete facts on a sanitary landfill program. He'll point out its many benefits and its economies. He'll recommend the Caterpillar machine to do the job. Get in touch with him. Ask for an on-the-job demonstration.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

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YOUR TAXPAYERS GET
THEIR MONEY'S WORTH
WITH CAT-BUILT MACHINES



Courtesy California-Fresno Asphalt Co.

● EQUIPMENT used is shown from the rear. Dump truck is unloading into front hopper. This is followed by the slurry seal mixing machine and the squeegee type spreader box. Four men are required. Communication is provided between operator and driver.

TEN STEPS For Successful Slurry Sealing

ALEX STENMAN

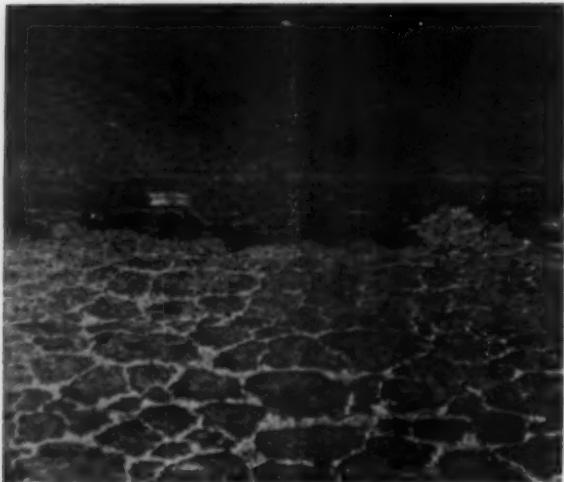
Supt. of Streets and Sanitation,
Fresno, California

WO METHODS for applying slurry seals to their streets are used by the City of Fresno. One is the conventional sled or slurry seal spreader box, which is charged with the slurry material from ready-mix trucks. The second method is a continuous flow pugmill type slurry mixing and spreading machine that had been developed in this area and which can apply the slurry at approximately five miles per hour; however the speed of this continuous flow machine must be cut down in City work due to irregularities, culverts, intersections, etc.

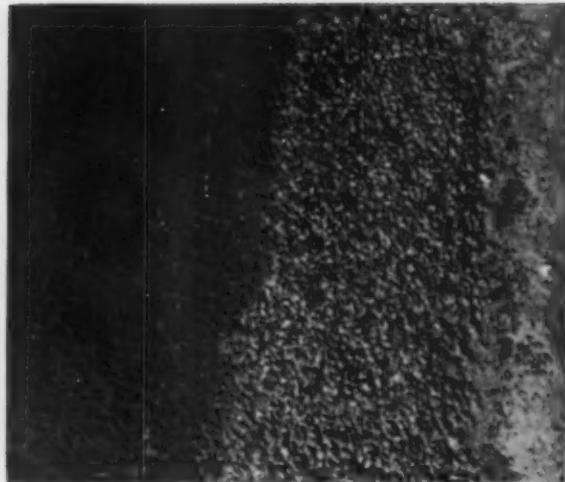
With proper application, the slurry will penetrate and seal cracks, fill small depressions, and produce a good level traveling surface. The seal will also prevent future oxidation and unraveling of the old street surface and will protect the sub-base. The seal will not only improve the riding quality of the roadway, but will have relatively good skid proofing qualities provided the proper aggregates and application are

STEPS TO BE FOLLOWED IN SLURRY SEALING

1. Test aggregates and asphalt emulsion in Laboratory; or by a consulting engineer; and/or by the asphalt emulsion manufacturer.
2. Make inventory of streets and program those streets which are suitable for slurry seal.
3. Clean streets by sweeping and washing; repair all holes and high places.
4. Notify all affected residents that the street will be closed during the operation, usually for a day or two. Notify the police, the fire department and utility companies.
5. Give equipment a final check to be sure everything is ready to operate; barricade the street.
6. Tack street with one part (SS1 or SS2) asphalt emulsion to 3 to 4 parts of water. Apply to street at rate of 0.1 gal. psf with a driving pressure of about 90 psi at the fan type spray nozzle.
7. Mix slurry seal (about 42 gals. mixing type asphalt emulsion, plus water, per ton of aggregate) to the proper consistency and spread at an even speed. Have at least two men with squeegees to spread any uneven application that may occur.
8. Sand over pedestrian crossings and intersections where traffic must pass. Allow as much time as possible before spreading sand.
9. Keep traffic off the slurry seal until it has hardened sufficiently to bear traffic, which will be a half day to two days, depending on the weather conditions and thickness of slurry application.
10. As an added precaution against pick-up spread a small amount of sand over the dried seal, or sprinkle lightly with cold water.



● PAVEMENT in foreground shows block or map-type cracking. In rear, how slurry seal works pending resurfacing.



● CONTRAST between pop corn type chip seal starting to ravel and section slurry sealed to fill voids and stop ravel.

used. We have found that maintenance costs go down and the street is preserved for a longer life with proper use of slurry seal based on studies prior to the application.

As mentioned in the first of the ten steps for successful slurry sealing, it is important to make field and laboratory tests before doing any slurry sealing work. Even during the work, and during the off seasons when no slurry work is being done, tests should be conducted. The continued success of slurry sealing depends on constant checking and improving. In new territories or in localities where unsatisfactory results were obtained in past slurry sealing special studies and analyses of the aggregate should be made to determine whether they have peculiar hydrophilic characteristics. Also, certain qualities and characteristics of the aggregates and the asphalt emulsion itself may make the slurry seal hard to work, or uneconomical to apply due to a short wearing time. A testing laboratory or consulting engineering firm can detect and remedy these deficiencies and make slurry work economical and profitable in almost any area.

A street inventory, step number 2, is usually taken care of by the Engineering Department. In our case the Public Works Department makes a complete inventory of all city streets from which the Engineering Division schedules a five or ten-year improvement program. This program itemizes the streets to be reworked, those which need major repairs, those which need complete rebuilding, and those which are to be slurry sealed for life prolongation. From this program the budgets are planned and approved.

The preparation of the street surface, item 3, is to slurry sealing what a good sub-base is to a street or road. A dirty street surface may result in peeling, excessive wear, air bubbles or other unsatisfactory results. The street should be swept thoroughly, then flushed or hosed clean. All depressions or humps that are excessive in size should be repaired. When holes are repaired with plant mix the work should be done long enough in advance of the seal for the patch to cure, because an asphalt emulsion will not stick properly to uncured pavement while the volatiles are still being released. Fine dust in cracks will not let the slurry seal penetrate sufficiently into the cracks for a good seal, so thorough cleaning is necessary.

The more common method of application of slurry seal is the use of City forces with the conventional spreader box. We use force-account labor, with our ready-mix trucks for mixing and delivering the slurry seal. This method may prove to have lower overall costs but it will take a longer time to complete a program. However, very good results may be obtained if due care and control of the mix is maintained. A second method of application is the use of a high production machine that mixes and lays the slurry seal in one operation. This type of machine can travel down the highway at a rate of five miles an hour and will lay an excellent slurry seal. The machine can handle 400 to 500 tons of material a day, laying approximately 100,000 square yards of seal per day. This rate of speed cannot be maintained in a city because of irregularities of the street, intersections, barricading requirements, traffic

control, etc. However 25,000 to 30,000 sq. yds. per day seems to work out satisfactorily for cost and traffic control factors.

Notifying the Public

Step number 4 is very important. Public relations cannot be overlooked. We attach notifications to the door knobs of the residents who front on the street which we are to slurry. We also talk to them about the procedure. We are particular to request them to park their cars on a side street or elsewhere during the drying time. In essence, we mention that the street will be tied up from 8:00 am. of a given day and that the street will not be opened to traffic for a day or two. We mention the asphalt product to be used, and the difficulty encountered in removing the product from clothes and rugs. We mention that we would be most appreciative if they would prevail upon their youngsters to keep out of the slurry seal. This publicity has produced wonderful cooperation from the public and we are very grateful for it, because vehicles traveling on a new slurry seal job are disheartening, to say the least.

Step number 5, equipment readiness, is one of the items that is often overlooked by beginners and in some cases by old timers. When city forces or contractors' crews are held up due to breakdowns, slurry sealing costs go up; the City Hall phones start ringing; and complaints are numerous. The public, informed that the job would be completed at a certain time, will be disappointed. Without their respect and consideration, cars, bicycles and other things may get on the newly run slurry job, with injurious results. There-

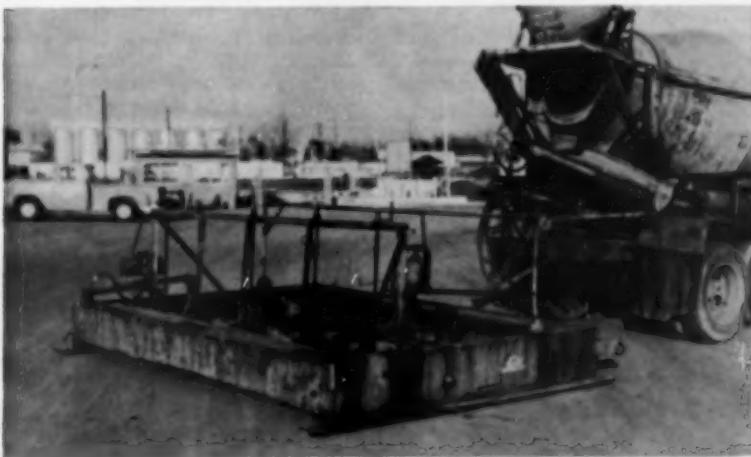
fore, be sure the equipment is ready to operate. Then barricade the street according to the recognized standard, and keep the slurry seal job rolling to completion. Place a sign on each end of the project mentioning that the street is being improved as a public convenience.

Item number 6. In many places a tack or prime coat is not applied prior to the actual slurry seal. It may or may not be necessary. Better results are usually obtained when a tack coat is applied. The cost of a tack coat, which also acts as a seal, will be less than a cent a square yard. A tack coat is applied to the street with a conventional spreader truck. The tack coat or primer presently used consists of either SS1 or

that the thin brown fluid material is actually sucked into the cracks, causing the dusty dirt to be stabilized and making an excellent binder for the slurry seal.

Slurry Seal Operations

Step number 7 is the actual slurry seal operation. The slurry used in this area is different from any of those observed elsewhere in that we use a coarser aggregate and make a spread over 1/8 inch thick. In the fall or during our mild winter months, we use SS1 mixing-type asphalt, whereas in the hot summer we use SS2 mixing-type asphalt emulsion. The coarse angular crushed rock mix produces more body and makes a thicker wearing



● CONVENTIONAL spreader box used by the city for applying slurry seal produces excellent results but is slower than the machine that does job in one operation.

SS2 asphalt emulsion, mixed to the proportion of 1 part asphalt emulsion to 3 to 4 parts of water, spread at a rate of 0.1 gal. ps. A pressure of 90 psi is maintained on the spreader bar and the spray nozzles are set so as to drive the liquid into the pavement at an angle of about 70° toward the front or forward motion of the spreader truck. This has a tendency to churn up and mix any fine dust that is on the pavement surface. At 90 psi the spray hits the pavement with sufficient force to penetrate cracks and loosen sticky particles on the pavement. In our operation it is not necessary for the tack coat to dry to the black tacky state before applying the actual slurry seal. For that matter, it may be better to move onto the job with the leveling slurry course before the prime coat is too dry (say after about 15 minutes), as under these conditions the trucks will be prevented from picking up the seal on the tires. Observations of the prime coat will show

surface. This prevents bald spots from showing, a condition prevalent with the fine mixes. Costwise, it was found that a fine mix with a minimum of five pounds per square yard costs about 6¢ per square yard, whereas our coarse mix of ten to eleven pounds per square yard costs about 10 or 11 cents per square yard. The life expectancy of the seal should be increased from a normal two years for the fine mix, to five to six years for the coarse mix.

Table 1 is an itemized gradation of the coarser mineral aggregate used in our slurry seal. From this it can be seen that the material is coarser than recommended by the Asphalt Institute. It does, however, fall within the boundary of the recommendations.

The sand equivalent of the mix we used was 79 percent and the blend, or final mix, consisted of 1/3 plaster sand, fine rock dust, and 1/3 coarse dust with a gradient from 3/16" maximum to fine dust. The labora-

tory recommended a mixing-type asphalt emulsion (Bitumuls DM-1h) in the amount of 18 percent. The wet track abrasion test for this mix showed a wear loss of about 35 grams per square foot, or a wear loss of about 4 percent.

The specifications for the mixing-type asphalt emulsion that was used are shown in Table 2.

Using a spreader box, with labor by city crews, the cost for the season's program involving 195,000 sq.



● PARTS of two test panels show wear characteristics of slurry mixes subjected to the wet track abrasion test. Top half used a mix with 20% SS2 mixing-type asphalt emulsion and bottom half uses 15% emulsion in the test sample mix.

yds. of slurry seal was: For cleaning and patching, labor \$2,600, equipment \$520, cost per sq. yd., 1.6 cents; for applying slurry, labor \$4,000, equipment \$1,070, cost ps., 2.6 cents; miscellaneous, labor \$775, equipment \$200, cost ps. 0.5 cent; material ps. 4.1 cents. Total cost was 8.8 cents ps.

When the City of Fresno's slurry seal program was co-ordinated with the contractor, the slurry application machine was operated in part with City personnel and acceptable work was performed at a high rate of speed. The City crews cleaned and

Table 1—Mineral Aggregates for Slurry Seal

Sieve Size	Fresno	Asphalt Institute
	% Passing	% Passing
3/8"	100	...
No. 4	97	100
No. 8	82	95-100
No. 16	63	70-95
No. 30	46	50-70
No. 50	25	30-50
No. 100	14	10-25
No. 200	10	2-10

Table 2—Specifications for Mixing-Type Asphalt Emulsion

Bitumuls specification designation	DM-1 SS-1	DM-2 SS-2
Tests on Emulsified Asphalt:		
Viscosity, Saybolt Furol @ 77°F., Secs.	20-100	50-400
Residue by Distillation, percent	55-60	60-65
Settlement, 5 Day, percent	3-	3-
Sieve Test (Ret. on No. 20), percent	0.10-	0.10-
Cement Mixing Test, percent	2.0 -	2.0 -
Dehydration	0.60+	0.60+
Adhesion (when aggregate requires), percent	75+	75+
Tests on Asphaltic Residue:		
Penetration @ 77°F., 100 g., 5 secs.	100-200	100-200
Solubility in CCl ₄ , percent	97+	97+
Ductility @ 77°F., cm.	40+	40+

barricaded the streets, helped in the adjustments of the spreader box, took care of traffic control, and kept the public informed as to the progress of the program. The contractor was paid on a unit price basis which brought the total cost to approximately 1 1/4¢ per square foot. The city crew in conjunction with the contractor applied slurry to about 58,000 square yards of streets. The City bought the material and paid the contractor 4 cents psy for furnishing the equipment and labor for applying the slurry. The dry material used by the contractor's machine had to be blended at the rock plant which brought the material cost to \$1.20 more per ton than if delivered separately to a mixer truck. Thus there was a slight increase in the material cost and subsequently a slightly higher overall cost per square yard. On an open highway the unit cost may be slightly lower.

When the City of Fresno uses its spreader box, City forces do all the work. We are fortunate to have a very good foreman in charge of the slurry operation and he has a crew that does an especially good job. They control the exact amount of water in the slurry, thus holding a consistency which prevents the coarse aggregate from segregating. We also have sufficient fines in the material to make a good matrix slurry which shows little segregation during the lay down. An even, good-appearing texture on the street surface results.

Mixing Techniques

If slurry is too dry, it will not spread. If it is too watery, the coarse material will separate. One of the practices found helpful in this dry region is to add water to the aggregate prior to applying the SS-1 or SS-2. We found that satisfactory re-

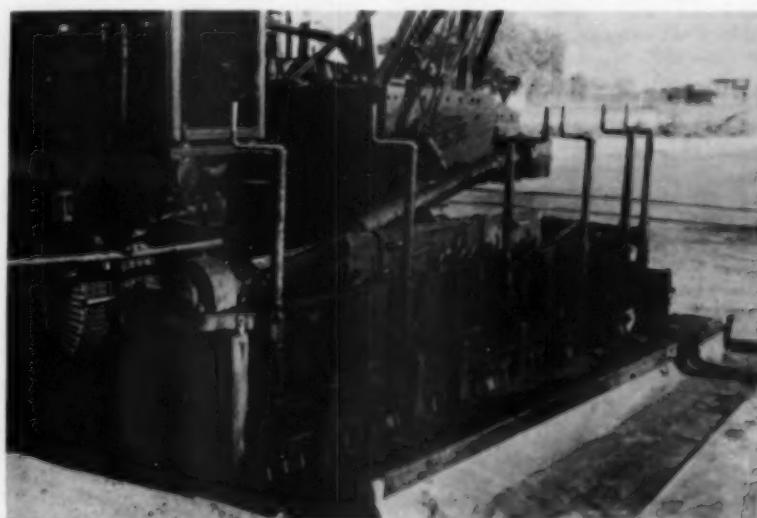
sults were obtained by mixing and adding water to the aggregate until the moisture content is 9 percent, and then adding the mixing-type asphalt emulsion. The contractor's machine operates on a similar principle of adding some of the water first. Apparently, the rock has greater affinity to water than the asphalt emulsion. After mixing for a short time, the mix is observed and more water is added to bring the slurry seal to the proper consistency for spreading.

If the aggregate is too dry, and the asphalt emulsion is added directly to it, the water content of the emulsion is reduced. This may cause the emulsion to break and return the asphalt to its original form and characteristics. In this sticky asphalt state, it can no longer be used as an emulsified application of slurry seal. Once this happens, it is practically impossible to lay slurry and it is

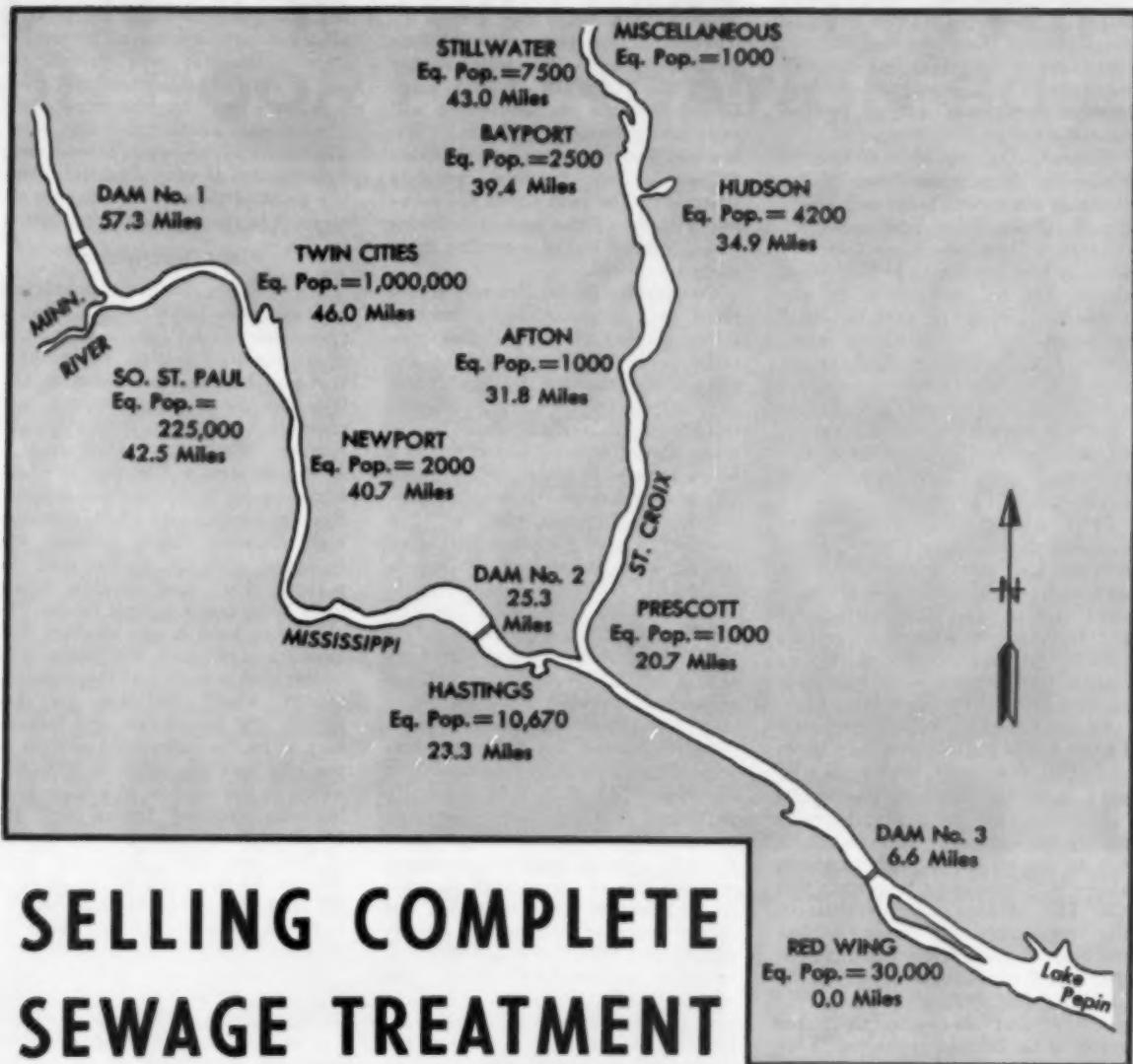
equally as difficult, or impossible, to add water. One who has experienced and observed the discouraging results of a break in the asphalt emulsion usually has their enthusiasm for slurry seal operations dampened. Even a partial break in the emulsion will produce poor results in appearance as well as being detrimental to the durability of the finished job.

Slurry seal as now applied is not the ultimate answer but it is a move in the right direction and has definite advantages in the street maintenance program. Slurry seal can increase the life of the street and protect the sub-base. In this way moneys are made available to bring the deficient streets of the community up to modern standards of construction with sufficient base and a high caliber traveling surface. In the meantime, it should not be overlooked that slurry is an economical street maintenance medium and that it will give good lasting results. It is a relatively new process and therefore all facets should be analyzed closely. Many improvements are still to be made. Both new and improved machines and methods of application need to be developed, along with better emulsions and aggregates which will increase the durable life of the streets and highways.

I wish to acknowledge the work of W. C. Bradshaw and his firm, the California-Fresno Asphalt Company, who developed the continuous mixing slurry machine; and William Furniss, of the American Bitumuls & Asphalt Co., whose firm developed the wet track abrasion test. In addition thanks are due to many other men who helped develop the slurry seal method.



● MECHANICAL spreader box is mounted on the mixer and obtains even distribution of the slurry seal by means of augers which turn in opposite directions.



SELLING COMPLETE SEWAGE TREATMENT

R. L. SMITH
and
H. C. LEIBEE
Consulting Engineers,
St. Paul, Minnesota

THE Mississippi River is an important part of Red Wing, Minn. The city is built on the bluffs and is near the upper end of Lake Pepin, downstream from St. Paul. There is a large municipally owned harbor for small boats and yachting is an important amusement.

The need for construction of the city's extensive large intercepting sewers emphasized the further need for waste treatment and an engineering study and report were authorized by the City Council. The basic premise of this report was that hundreds of copies were to be

TO A CITY

printed and circulated among all interested people. It was considered also that the report would include all the necessary facts as to the river conditions and the basic relation between primary and complete treatment of the waste. It is the writer's carefully considered opinion that when all the facts are put in front of all the people, the taxpayers will, almost inevitably, authorize the use of complete treatment.

Most people like to do a good job and a primary treatment plant does not do what the public considers first class treatment — very few laymen can accept a condition wherein a large sum of money is spent for thirty percent "efficiency." The people of Red Wing studied the facts for about a year and then the decision was made to use complete treatment.

The Report

The facts reported are summarized as follows:

Sewage Discharge above Red Wing: The report included a map, of the two rivers, St. Croix and Mississippi, with distance in miles above Red Wing and the calculated amounts of sewage in terms of equivalent people for each municipality as discharged in the river at

this time. The sewage from a population of about $1\frac{1}{4}$ million is being emptied into the river and natural treatment in the river has reduced this sewage to a population equivalent to two-thirds million by the time it reaches Red Wing.

Sanitary Quality of the Stream: While the Mississippi River above Hastings can have a large deficiency, the St. Croix River adds sufficient dilution to this water, so that extremely bad conditions at Red Wing should not be anticipated. It was pointed out, however, that, as would be anticipated, the coliform count in the river is quite high. A recent survey of bacteriologists all over the country expressed an opinion that most viruses would be present in the sewage entering Red Wing; also that many pathogenic bacteria and protozoa could be present.

Most adults have immunity to most of the diseases either by infection and getting well or by natural immunity. There is no basic need to fear an epidemic—the hazard lies largely with the younger generation. The exception is by disease not common to this country but brought in by travellers.

Legal Right to Pollute Streams: Legal opinion is very definitely to the effect that public waters can be used only by municipalities as a "reasonable use" and that there is no "right" belonging to municipalities to use all the available oxygen above that necessary to sustain fish life. The obvious interpretation of the "reasonable use" theory is that the cost of the project come within the limits of reasonable ability to pay and the difference in cost of primary and complete treatment rarely goes beyond the term "reasonable."

Treatment by Up-Stream Cities: Those treatment plants located on

the Mississippi River above Minneapolis are classified as "complete" treatment. This is because Minneapolis gets its drinking water supply from the river. Below the Twin Cities, Hastings and Stillwater will provide primary treatment but Hudson and the communities above Stillwater will provide complete treatment. The twin Cities are making a study of the basic conditions to the implied end of providing complete treatment.

Community Pride: Primary treatment will remove approximately thirty percent of the polluting material and this would reduce the sewage represented by equivalent people in the river from 670,000 to 660,000—a difference that would mean almost nothing and still cost a lot of money. If complete treatment (90 percent removal) is to be provided, the City will then be in a position to be the leader in cleaning up the river and also would be in a position to force the up-river to do their part.

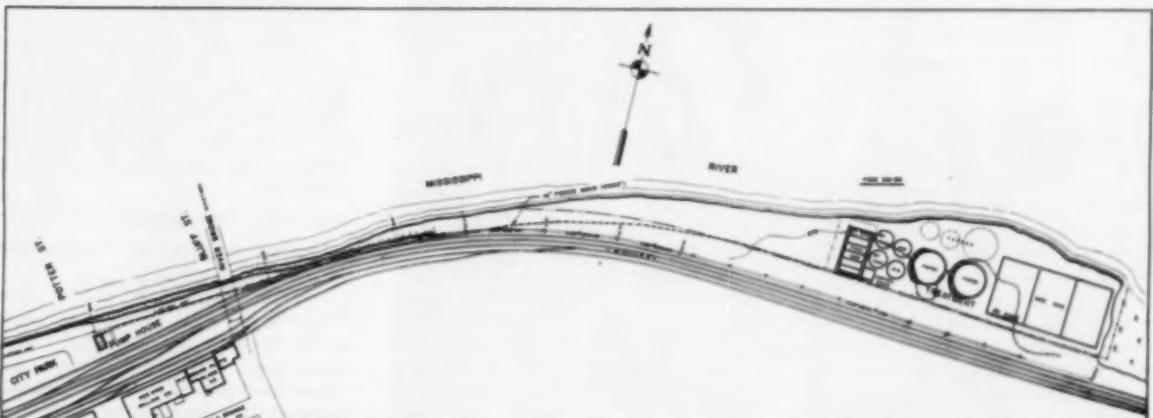
Cost of Primary vs. Complete Treatment: A primary plant, consisting of the customary settling tanks and digester, will cost about sixty percent of the cost of a complete treatment plant having two sets of settling tanks, filters and digesters. The theory is generally expressed that a primary plant can be constructed and then additions made to provide complete treatment without loss of investment. Actually, a primary plant normally has larger tanks for settling than a complete type; the pumps are designed to pump against lower heads; two contracts will always cost more than one, particularly when consideration is given to inflation and, over the years, there has been a steady tightening of state standards. Two-stage construction can reasonably

be anticipated to cost 120 percent of the cost of single stage construction of a complete treatment plant. The state authorities will permit the use of two-stage construction, using a primary type plant for a few years, adding the additional units later. The economy, however, of two-stage construction is very doubtful. From the point of view of cleaning up the river, it is strictly a delaying action.

Plant Description

The present domestic population approximates 12,000 people. With a projection of the future population plus industrial wastes, the equivalent population is estimated as 45,000. The plant will include a mechanical bar screen, triturator, grit removal mechanism, 1400 gpm to 4200 gpm pumps, 2000 feet of 16-in. cast iron force main; dual primary Spiraflo tanks; dual 88-ft. diameter high capacity filters, housed and equipped with tile media; dual digesters; dual final settling tanks; sand beds; and a control house. The plant will have a wet weather flow capacity of six mgd. The topography of the land is such that the pumping station which includes the bar screen, grit mechanism and laboratory is in the downtown section of the city and the plant is 2000 feet away, in the shadow of a huge bluff between railroad tracks and the Mississippi, on a long narrow strip of land well away from any residences. As the plant site is on river fill land, the complete plant will be built on concrete piling about 50 ft. long.

Bids were taken and the City Council ratified the contracts. The aggregate bid for the plant, including that part of the pumping station normally considered as part of the plant approximated \$1,200,000 or about \$27 per equivalent capita.



● COMPLETE treatment is provided by Red Wing in a plant down stream from the city and well away from any residences.

SERVICE BUILDING ERECTED ON POOR FOUNDATION SOIL

N. G. DAMOOSE, City Manager, Traverse City, Michigan

A LONG-NEEDED garage has been constructed by Traverse City, Mich., utilizing available area at the site of the newly expanded sewage treatment plant. The garage was built at the same time the treatment plant was enlarged. The approximate cost, according to N. G. Damoose, City Manager, was \$41,720. This was paid for wholly by the City, though federal assistance was received under PL660 for the improvement of the sewage treatment plant, the cost of which was \$560,000.

Limited funds required rigid economy in design and construction of the garage; also, at the most suitable site, which was near the sludge digester, soil conditions were poor, with bearing values limited to around 400 pounds per sq. ft. McNamee, Porter & Seeley, consulting engineers of Ann Arbor, were retained to design the building and supervise its construction. It was decided to utilize, as the basic structure, an Armco steel building. This reduced design time and permitted quick calculations of footing areas needed to support the frame.



● SERVICE building for sewage treatment plant is shown in the background. This is designed around an Armco steel building. Digester control house in foreground.



● INTERIOR view of building shows space available for vehicle storage. Dimensions are 50 ft. by 100 ft. with a full roof height partition; it is fully insulated.

The building, which is 50 ft. wide and 100 ft. long, has walls of cement block 14 ft. high, faced with a veneer of yellow brick. It is fully insulated and heated. A full roof height partition was provided by welding channels to the underside of the rigid frame rafters and field-cutting Steelox panels to fit.

The garage includes facilities for minor repairs only. Major repairs to equipment are made at the City Garage by trained full-time mechanics. Equipment normally stored and in use at the new garage includes the following: three Gar Wood Load Packers, 12, 13 and 16-yard capacity; three dump trucks, 3 and 4-yd. capacity; a 1½-ton flat body truck; a T-9 bulldozer; three Rex pumps, a 6-in., a 3-in. and a 2-inch; a 125 cfm air compressor; a Flexible sewer machine on a 2-wheel trailer and two units of a sewer bucket machine; a Barber-Greene portable conveyor; a ½-ton pickup truck; two portable cement mixers; a well point system; a limited kerosene supply; spare tires, fire hose; barricades; and hand tools.

CONTAINERIZATION



● R. POWELL BLACK is City Manager of Dothan, Ala. He spearheaded the drive for improvement in refuse collection facilities which resulted in saving some \$50,000 per year for the city.

SAVES



● CONTAINERS of various sizes are used. This is a one-yard size, of which 58 were used. In all, there are 220 containers, the largest having capacities of 8 cubic yards.

ONE OF THE LARGEST mass conversions to container refuse service ever attempted has been completed by Dothan, Ala., a city of 30,000 population. Altogether 220 containers were involved, ranging in capacities from 1 to 8 cubic yards. These were placed at commercial buildings, schools, supermarkets and industrial plants throughout the city and are served by two Dempster-Dumpmaster self-loading packer trucks.

The two major benefits Dothan will realize from the new system, according to City Manager R. Powell Black, are labor savings of \$50,000 annually, or about \$1,000 per week, and more sanitary storage of refuse.

In planning the solution to the problem, a detailed survey was made of the points in both downtown and outlying areas from which large volumes of refuse had to be removed. Each commercial refuse accumulation point was visited and the cubic yardage generated each week was computed and entered on work sheets. Trip sheets and truck routes were analyzed and collection trucks were followed to verify loads and check storage conditions. Personnel records and payroll figures, as well as operational and maintenance costs for truck equipment, were studied.

When the survey was completed, the following facts came to light: 1) Nearly 1800 yards of refuse were being generated in the commercial service area each week. Direct labor costs, not including equipment, to collect and haul this volume of material to the disposal area required a large portion of the \$131,696 annual payroll for Sanitation Department laborers. Handling costs approximated 65 cents per cubic yard.

2) Handling costs for large commercial firms and industries in outlying districts were disproportionately high, amounting to as much as \$6,000 annually in one instance. 3) At many locations trash scattered from boxes and overturned cans not only constituted a serious fire hazard but also was wasting the time of trucks and the crews who had to move up and down alleys, picking it up. Rehandling of trash from wood and wire bins also required a lot of time by collection crews. 4) A situation of rapid turnover existed in the Sanitation Department. This led to inefficiency from the use of inexperienced personnel and created a need for an almost constant training program. 5) Widespread dissatisfaction over conditions existed among the majority of merchants and civic leaders, including the Houston County Health Department.

With past experience in three other cities, Mr. Black felt that a mechanized container system would overcome the conditions that ex-

isted in Dothan. In arriving at the type of equipment to employ, he visited several large Southern cities to investigate the different types of equipment in use. Performance figures and cubic yard costs were obtained.

After several meetings with the Sanitation Department and with city officials, the decision was made to install the Dempster-Dumpmaster self-loading packer, and a number of steel Dumpmaster containers.

How the System Works

The Dempster-Dumpmaster System consists of a number of detachable storage containers placed at points of waste or refuse accumulation. As these containers are filled, the truck-mounted Dumpmaster makes its rounds, picking up each container and emptying the contents into its packed body. Here, the material is compressed to a fraction of its former volume by action of a hydraulically-powered packer plate, enabling the Dumpmaster to haul

OF COMMERCIAL REFUSE

\$1000 per Week



● REFUSE storage needs for this 100-family project are met by a few containers.



● STORAGE for refuse from this variety store is provided by an 8-yd. container.



the equivalent of many truck-loads of material on one trip to the disposal area.

The figures compiled in the original cost-finding survey gave an accurate index to the size of the containers and number of pickups per week each would require, based on the rate of accumulation at each point. After this information was assembled, Mr. Black requested the City Commission for funds to purchase two Dempster-Dumpmasters and 220 containers. Of these 58 were 1-yd.; 67 were 2-yd.; 14 were 3-yd.; 6 were 4-yd.; 50 were 5-yd.; 17 were 6-yd.; and 8 were 8-yd. At some points, where access to the container by the Dumpmaster was not feasible, containers with casters were recommended.

Competitive bids were received and the equipment was purchased from Dempster Brothers. Delivery was made by railroad gondola cars, and the containers were held on a siding until the job of installation was completed. Installation crews moved containers to each location, cleaned up the premises and removed old wire and wooden bins. Containers were placed at a convenient location for the store or stores that would use each one. In a few instances, it was necessary to deviate from the plans based on the original survey.

Store managers were given detailed instructions on how the containers were to be employed, what they could expect in the way of pick-up schedules, and advised of what the city expected of them in the way of cooperation. The system officially went into operation early last December, with partial service existing for a short time before the entire city was converted.

When the new service was initiated, it was necessary to revise the entire residential garbage collection system to avoid overlapping routes and enable all citizens to have service twice each week. Prior to this, some citizens received service three times a week, others twice a week, others once a week and still others on an irregular basis.

After four months of operation, the city officials, merchants and civic leaders are enthusiastic over the cleanliness and money-saving fea-

● END OF THE ROAD: When the disposal area is reached, refuse in body is discharged by running the plate back.



● THE TWO Dumpmasters operated by Dothan are painted a pale blue to match the containers spotted throughout the city, while the cabs are bright red. Each unit is equipped with an automatic hopper cover and a movable steel hopper extension.

tures of the new system. The projected savings indicated in the initial survey were surpassed. However, Mr. Black feels that it will take about six more months to obtain realistic figures on costs. The labor costs alone (not including the truck operation costs) dropped to 7¢ a

cubic yard—an almost unheard-of figure in municipal collection.

The previous system, including residential collection, had required 51 men (37 laborers and 14 drivers) and 13 trucks, with one truck being used on a double shift. The new system reduced the number of

laborers and drivers to 31, which will save the city \$50,000 per year in salaries and fringe benefits alone. With four trucks removed from service, further savings will be effected in operation, maintenance and replacement costs.

In addition to the savings in labor costs, the new system is providing wind-proof, rat-proof, fire-proof, fly-proof storage of garbage and refuse. Neat, sanitary containers have replaced unsightly trash cans and bins. Injuries to Sanitation Department employees have been considerably lowered, and the fully enclosed compaction bodies have eliminated the scattering of material in transit.

Mayor Earle C. Moody and City Commissioners Davis and Thrower are pleased with the reaction of the public. G. H. Parrish, Jr., Superintendent of Sanitation, assisted in the surveys and planning and directs the new program. Harold E. Meeks is City Engineer and Floyd Clayton, assistant. William Bailey is Administrative Assistant to the City Manager.

Highway Department Field Laboratory Features Diamond Drilling Equipment

A MOBILE laboratory that brings testing facilities to the construction site has been outfitted by The Michigan State Highway Department's office of Tax and Research. Two laboratory technicians man the specially equipped truck and conduct the tests on bituminous surfacing.

A Truco Model B portable diamond drilling machine, made by Masonry Drilling Division of Wheel Trueing Tool Co., Detroit, is used for removing core samples from the roadway. The unit is lowered to the ground by a hoist and rolled to the coring location on its own wheeled and castered platform. Diamond drill bits from 1" to 14" in diameter are used with the Model B, providing cores of various sizes for different test purposes.

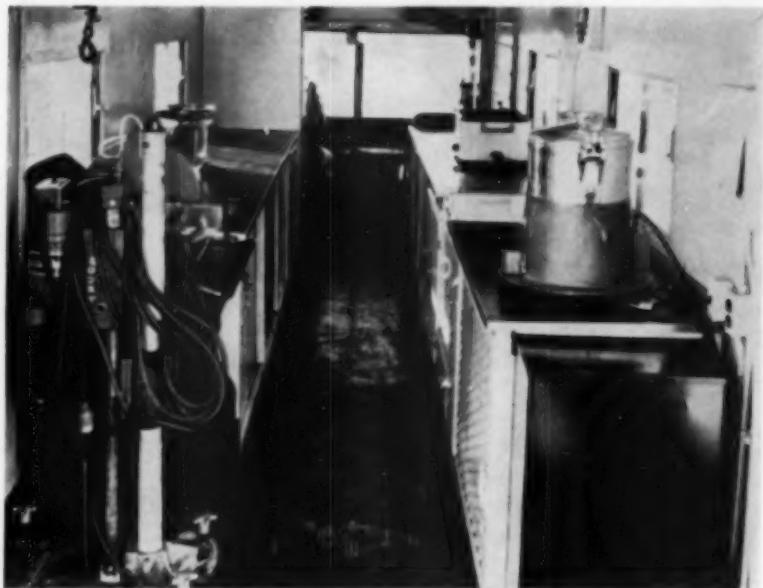
Information obtained from the tests is used in making adjustments in bituminous design, construction procedures and general control of quality of bituminous surfacing.

The usual practice is to take samples from the roadway and ship them to the Department Laboratory in Ann Arbor for analysis, a time consuming process compared to

having test facilities at the construction site. This mobile laboratory supplements conventional testing methods and serves as a

"trouble shooter" on jobs where more than the usual quality control is desired.

In addition to the normal testing equipment the truck features its own water tank, gas stove oven and a gasoline generator for powering various pieces of equipment. With its own power and utilities the laboratory is fully self-sufficient.



● MICHIGAN State Highway Department's mobile field laboratory takes testing facilities to the construction site. Truco portable drilling machine is shown at left.

THE DESIGN OF SMALL WATER SYSTEMS

JOSEPH A. SALVATO, JR.,

Director

Division of Environmental Hygiene, Rensselaer County Department of Health, Troy, New York

FOR THE PURPOSES of this article, small water plants are those capable of supplying 15,000 to 200,000 gpd. Some authorities believe that 200 persons is the smallest population group for which a water system can be constructed that can be self-supporting. Obviously, the range is an arbitrary one, and much of this discussion will apply to all plants. Principally, however, it is planned to restrict the text to the problems peculiar to the small water plant: The design standards indicated under the circumstances; the equipment manufactured to serve these special needs; water quantity; sources and treatment; water quality problems; pumping; distribution; storage; and related factors.

Much time and effort are often spent in promoting a new water works or needed improvements. Long term plans and a design to permit step construction program may make practical what might at first appear to be financially impossible. Conferences in the planning stage with local officials, health department sanitary engineers, the local fire rating organization, the state geologist and the United States Geological Survey representatives are valuable in providing basic information.

Of the 22,676 communities surveyed by the United States Public Health Service (including all incorporated communities of 100 population or more in 1940 and those unincorporated communities of 500 popu-

lation or more in 1940 for which figures were available), 5,926 had no central water system. In 1950 it was estimated that 8,436 communities under 1,000 population, and 6,047 communities of 1,000 to 5,000 population, had public water supplies. But only 60.5 percent of the communities under 1,000 population were served by public water supplies, and about 65 percent of places under 500 population received untreated water. Jordan (1) also points out that "the great number of water systems in small places presents a challenge to the technical advance of our water supply operations. One cannot reasonably expect that in a town of 1,000 or less, the water works operator will be a technical school graduate or even one who has acquired his skills through other than unplanned experience."

In the study of water plants, the larger the volume of water treated the more impressive is the plant, and the treatment and distribution units involved. Textbooks and handbooks are usually quite complete in their review of the factors involved in the design of large plants. Presumably the same principles can be applied to small plants, provided they are adjusted to recognize the limited skill normally available to operate such plants. Methods of making these adjustments and other factors which deserve recognition in small water system design are discussed in the following text.

*The material in this article is based in part on the book by the author,
Environmental Sanitation, published by John Wiley & Sons, Inc., New York, 1958.*

PROBLEMS OF THE SMALL PLANT

Hopkins and Elder⁽¹⁾ classified the water-borne disease outbreaks in the United States from 1920 to 1945 into separate categories based upon reports made to the Public Health Service by state and local health departments. They found that 136 outbreaks (19 percent) involved use of contaminated or polluted surface water supplies accounting for 35,419 cases (16 percent) of typhoid fever, paratyphoid fever, dysentery, and diarrhea. Water supplies from shallow wells, deep wells and springs accounted for 269 outbreaks (37 percent) and 26,288 cases (11 percent). Pollution of cisterns and reservoirs caused 11 outbreaks (1.5 percent) with 2,054 cases (1 percent). Failure of treatment processes and inadequate treatment of drinking water caused 98 outbreaks (13.5 percent) with 80,390 cases (35 percent). Pollution of the distribution system caused by breaks, construction, cross-connection or back-siphonage and leaking sewers caused 88 outbreaks (12 percent) and 57,565 cases (25 percent). Seepage of surface water into storage facilities and use of a polluted source caused 20 outbreaks (3 percent) with 13,741 cases (6 percent). Miscellaneous causes accounted for 103 outbreaks (14 percent) with 14,186 cases (6 percent). Of the total of 230,643 cases from 725 outbreaks, 14,595 cases were typhoid fever and paratyphoid fever, and 216,048 were dysentery and diarrhea. Gainey and Lord⁽²⁾ made a similar study of 782 intestinal disease outbreaks in the United States and Canada for the period from 1920 through 1945. Polluted surface and underground water supplies were responsible for 56 percent of the outbreaks; breakdown in water purification accounted for 14 percent; 18 percent were due to pollution of safe water supplies during distribution, and 12 percent were due to miscellaneous causes.

A study (2), based upon a report by Wolman and Gorman, is of value in showing the water-borne disease outbreaks between 1920 and 1945 for certain population groups. It was found that 221 outbreaks, 31.7 percent of the total, occurred in the 1,000 and under population group; 237 outbreaks, 34 percent of the total, in the 1,000 to 5,000 population group; and 239 outbreaks, 34.3 per-



cent of the total, in the communities larger than 5,000 population. It is apparent that water disease outbreaks occurred with the greater frequency in the small water supplies. There is no reason to believe that this probability has changed.

The need to obtain better water sources, design, operation and treatment for the small water plant is apparent. Also, as increasing demands are made of streams for sewage disposal it becomes more important to modify our bacteria-oriented thinking in water plant design and treatment to recognize that viruses, helminths, protozoa, yeasts, molds, detergents and other chemicals are found in sewage polluted water. Not all of these are removed by the normal processes of sewage treatment. Modern water purification methods applied under competent supervision may provide adequate processing of these waters for public consumption. But under those conditions, the technical operational competence needed to guarantee a water of satisfactory sanitary, chemical and physical quality at all times cannot be expected, or for that matter, economically justified at the small water plant. Therefore, resorting to the exploration of potential unpolluted surface and underground water resources may be desirable. But even with such water sources a minimum of treatment as turbidity removal, if required, and chlorination should be provided, as nearly automatic as possible.

In the design of a new water plant, or in the reconstruction of an existing system, there is a natural reluctance on the part of elected officials and private owners to abandon an old water supply, even though it is not entirely safe. It is the duty of the designing engineer to insist that such sources of water be physically disconnected from the water system, unless they can be reconstructed to yield a water of satisfactory sanitary quality. Also, in

case of emergency there is a great temptation to use any water that happens to be available. The separation of a potable and a non-potable water supply by shut-off valves or checks, singly or in series, is unreliable and is not an acceptable substitute for physical pipe disconnection. Studies of water-borne disease outbreaks have shown the fallacy and tragedy of permitting shut-off valves or checks in lieu of actual pipe disconnection.

Small Plant Operator Is Busy.

The typical operator of a small water plant also supervises or actually makes water service connections, reads meters, answers complaints and orders needed minor supplies and equipment. He may also argue his own case for more money before the town board, village board, or water company, pay for his own journals, run the sewage treatment plant, pump out flooded basements and operate the snow plow. He is lucky if he receives half the salary he is worth. Operators of small water plants have limited resources available to them, and are frequently called upon to perform unreasonable tasks. They get little support and appreciation; yet they carry out their job against odds in creditable fashion.

Because the operator is given many "additional duties," it is important that the small plant be simple and nearly automatic and with the "human element," insofar as possible, eliminated. This objective admittedly is ideal; but it is nevertheless something to be striven for and approached.

In their bulletin, "Policies Governing the Design of Public Water Supply Systems in Kansas," the Kansas State Board of Health states: "One of the most important features that the designer must consider is simplicity of operation. He should plan or select apparatus with a view to having it so made and installed that it will be difficult to operate it in any other way than that in which it was designed to be operated and with a minimum of attention.

"Certain inherent differences between large and small plants must be recognized. Financial limitations in initial construction costs and operating funds are the most potent

THE DESIGN OF SMALL WATER SYSTEMS

factors influencing the design of small plants. The methods of handling, storing and feeding chemicals and the method of operating filter valves illustrate differences between large and small plants which must be considered. Devices which require continuous interrupted (24-hour per day) supervision for satisfactory performance are not suitable for the smaller cities which are financially unable to provide three-shift operation.

The designing engineer is therefore obligated to take into consideration the local political picture, customs and practices so as to develop a design that will produce the desired results under the operating conditions likely to prevail in the particular situation. In the selection of mechanical equipment, the availability of service from the manufacturer or his representative, and the time required to obtain replacement parts should be evaluated when specifications are prepared and before a product is selected. There is no denying that many designs and types of equipment are available which will produce the desired results, if properly operated and maintained. In small water plants, because of the points mentioned, a design and equipment are needed which will produce the desired results even if improperly operated and maintained. Impossible—! Well, to the competent professional design engineer this is a challenge which will require just a little more ingenuity.

Quantity Considerations

Some of the specific factors which determine the amount of water used for domestic purposes are availability of water, the habits of the people, the number and type of plumbing fixtures provided, the water pressure, the air temperature, the newness of a community, the types of residential units, lawn sprinkling and gardening use and related factors. Where possible, the actual water consumption under existing or similar circumstances and the number of persons to be served should be the basis for the design of a water system. In addition, provisions should be made for fire and possibly for industrial needs and the trend of increasing per capita consumption.

In the absence of specific water consumption figures the estimates given in Tables 1 and 2 may be used as a guide. They should not be used blindly as wide variations are possible, dependent upon local factors.

The AWWA Committee 4440-M

Table 1—Estimated Water Consumption at Different Types of Establishments

Type of Establishment	Flow in Gallons, Per Person or Unit Per Day
Dwelling Units, Residential	
Private dwellings on individual wells or metered supply	50 to 75
Apartment houses on individual wells	75 to 100
Private dwellings on public water supply, unmetered	100 to 200
Apartment houses on public water supply, unmetered	100 to 200
Subdivision dwelling on individual well, or metered supply, per bedroom	150
Subdivision dwelling on public water supply, unmetered, per bedroom	200
Dwelling Units, Transient	
Hotels	50 to 100
Boarding houses	50
Lodging houses and tourist homes	40
Motels, without kitchens, per unit	100 to 150
Camps	
Pioneer type	25
Children's, central toilet and bath	40 to 50
Day, no meals	15
Luxury, private bath	75 to 100
Labor	35 to 50
Trailer with private toilet and bath, per unit (2½ persons) (a)	125 to 150
Restaurants (Including Toilet)	
Average	7 to 10
Kitchen wastes only	2½ to 3
Short order	4
Short order, paper service	1 to 2
Bars and cocktail lounges	2
Average type, per seat	35
Average type, 24-hour, per seat	50
Tavern, per seat	20
Service area, per counter seat (toll road)	350
Service area, per table seat (toll road)	150
Institutions	
Average type	75 to 125
Hospitals	150 to 250
Schools	
Day, with cafeteria or lunch room	10 to 15
Day, with cafeteria and showers	15 to 20
Boarding	75
Theatres	
Indoor, per seat, two showings per day	3
Outdoor, including food stand, per car (3 1/3 persons)	3 to 5
Automobile Service Stations	
Per vehicle served	10
Per set of pumps	500
Stores	
First 25-ft frontage	450
Each additional 25-ft frontage	400
Country Clubs	
Resident type	100
Transient type, serving meals	17 to 25
Offices	
Factories, sanitary wastes, per shift	10 to 15
Self-Service Laundry, per machine	15 to 35
Bowling Alleys, per alley	250 to 500
Swimming Pools and Beaches, toilet and shower	200
Picnic Parks, with flush toilets	10 to 15
Fairgrounds (based on daily attendance)	5 to 10
Assembly Halls, per seat	1
Airport, per passenger	2
(a) Add 125 gallons per trailer space for lawn sprinkling, car washing, leakage, etc.	2½

NOTE: Water under pressure, flush toilets and wash basins are assumed provided unless otherwise indicated. These figures are offered as a guide; they should not be used blindly. Add for any continuous flows and industrial usages. Figures are flows per capita per day, unless otherwise stated.

Table 2—Miscellaneous Water Usage Estimates

Unit	Normal Water Consumption
Water closet, tank	4 to 6 gal per use
Water closet, flush valve, 25 psi	30 gpm
Wash basin	1½ gal per use
Bathtub	30 gal per use
Shower head	25 to 30 gal per use
Garden hose, ½ inch, 25-ft head	200 gph
Garden hose, ¾ inch, ¼-inch nozzle, 25-ft head	300 gph
Fire hose, 1½ inch, ½-inch nozzle, 70-ft head	2400 gph
Continuous flowing drinking fountain	75 gph
Lawn sprinkler	120 gph
Automatic home laundry machine	30 to 50 gal per load
Dishwashing machine, home type	6 gal per load
Dishwashing machine*, commercial, stationary rack type, at 15 psi	6 to 9 gpm
conveyor type, at 15 psi	4 to 6 gpm
Garbage grinder, home type	1 to 2 gpd per person

*Does not include water to fill wash tank.

Water Use*	gpm	Total gal	gpcd
Automatic home-type washing machine	3 to 7	36 to 50 per load	6.5 to 9
Automatic home-type dishwasher	2.5 to 5	4 to 8 per load	6
Garbage disposal unit, home-type	1.5 to 2.5	...	3 to 4
Lawn sprinkler, 3000 sq. ft. lawn, 1-inch per week	...	1850 per week	75
Air conditioner, home-type, water-cooled, 3 ton unit, 8 hrs. per day, 2 gpm per ton	6	2880 per day	825

*Adapted from "Land Uses and Water Consumption Requirements," *Public Works*, 90, 120, April, 1959. (Abstract and condensation of thesis by Rodolfo Silva.)

(4) reported recently on domestic water use and the effects of climate and family income, residential-requirement trends and peak-demand data. A study of 113 metered water systems showed median water consumption ranging from 45 to 131 gpcd with extremes of 24 to 162 gpcd. In general, residential water sales west of the 100th meridian were double (in excess of 100 gpcd) those east of it (close to 50 gpcd). Family income is related to water usage but other factors also affect usage. A report of the American Water Works Service Co. on 58 systems east of the 100th meridian showed a water consumption of 111 gpd per service in 1939, increasing steadily to 142 gpd in 1956. Variations in peak demands in 51 systems between 1930 and 1956 confirmed that the maximum day is 1.5 times the average day. Additional storage of 10 to 25 percent to compensate for special summer lawn sprinkling, air conditioning and refrigeration was indicated from a study of five communities.

A study by Ralph Porges (5) based on Public Health Service in-

ventories as of 1954 showed that the median domestic municipal water consumption in 162 communities in 39 states ranged from 42 to 92 gpcd, with the higher water consumption in arid states. The median municipal water consumption in 1,474 communities ranged from 119 to 210 gpcd and averaged 143 gpcd. This survey included all communities of 10,000 population and over, and a 40 percent sample of communities having populations 5,000 to 10,000.

It must not be forgotten that large variations from the median exist and that these data may not apply to many small water plants. Metering could reduce water consumption by 25 percent or more. Water districts and water companies reported a consumption of 114 gpcd.

B. A. Poole, Director, Bureau of Environmental Sanitation, Indiana State Health Department reported (6) that, for the 1940 to 1954 period, the average annual increase in water consumption for municipalities in the 2,500 to 25,000 population range was 1.9 gpcd. The average water consumption in 1954 was 115 gpcd. In communities of less than

2,500 population the average annual increase in water consumption was found to be 0.43 gpcd and the average water use 62 gpcd in 1954.

A question to be decided early in the preliminary planning stages is the future population upon which to base the design. (See "Population Projections for Local Areas," Meyer Zitter, *Public Works*, June, 1957.) The estimated population 25 years later is a generally recommended basis, although certain parts of the water system such as mechanical equipment may be designed for a lesser period, and a reservoir, dam and drainage area may be designed for 50 or 100 years hence. In some instances it is desirable deliberately to plan for temporary installations with the full realization that they will be abandoned in a relatively short time.

Population growth in this country is now greatest in "exurban" or "fringe" areas of metropolitan centers and the trend is expected to continue. Yet in the development stages of these areas there does not exist an adequate tax base to finance utility systems which will be of sufficient capacity to serve the increased population of 25 years hence. There is a need for zoning and planning of such areas.

In general, small water plants serving residential communities should be designed on the assumption that the daily total consumption takes place in 12 to 16 hours. Proposed or potential building lots and existing dwellings can be assumed to contribute 3.5 persons per dwelling unit. If the maximum day is 1½ times the average day, and the daily water consumption 100 gpcd, the per capita plant design would be: $100 \times 1.5 \times 24 \div 6 = 600$ gpcd if the plant operates 6 hours a day; $100 \times 1.5 \times 24 \div 16 = 225$ gpcd if the plant operates 16 hours a day. (See "Peak Demand Estimate.")

The type of water plant, the need for attention, and the cost of operation versus the cost of additional plant capacity will usually determine the design operation period. Storage must, of course, be adequate. Storage and plant capacity for fire flow are additional considerations.

Many health departments have design guides or standards to assist the designing engineer. These are usually minimum standards.

Water Supply Sources

Long-term rainfall and stream flow data, as well as ground water information are available from the

Geological Survey, but these seldom apply to small watersheds. Rainfall data for specific areas are also available from local weather stations, airports, and water works. Unit hydrographs, maximum flows, minimum flows, mass diagrams, characteristics of the watershed, rainfall, evaporation losses, percolation losses, and future water consumption should be considered for design purposes and storage determinations where these are applicable. State and local health departments may have additional data.

A study in Kansas showed that where the annual rainfall was 40 in., the storage needed was at least 125,000 gallons per person using water, and the minimum drainage area tributary to the reservoir should be 2½ acres per person. Where the rainfall is 30 in./yr., either the storage or drainage should be 40/30 of the figures given. It is assumed that the water consumption is 155 gpcd. (7) The minimum watershed yield in New England has been estimated at 0.2 to 0.4 cfs per square mile with minimum stream flow averaging 0.10 to 0.12 cfs on small watersheds. The highly developed New York City Croton watershed has an average yield of about 1 mgd per square mile of drainage area with an annual rainfall of 46 in./yr.

Where pumping is needed, electrically-operated pumps should have gasoline or diesel standby units having at least 50 percent of the required capacity. Where standby units provide power for pumps supplying chlorinators and similar units, the full 100 percent capacity must be provided if gravity flow of water will continue during power failure.

Watershed runoff can be estimated in different ways. Flood runoff is unimportant in water supply except as affecting reservoir capacity and dam or spillway design.

A formula for estimating the average annual runoff is given by Vermuelé which may be written as follows:

$$F = R - (11 + 0.29 R) \\ (0.035 T - 0.65)$$

in which F is the annual runoff in in., R is the annual rainfall in inches, and T is the mean annual temperature in degrees F. This formula is reported to be particularly applicable to streams in northern New England and in rough mountainous districts along the Atlantic Coast. For small water systems, where the storage would be relatively small, it is suggested that design be based on

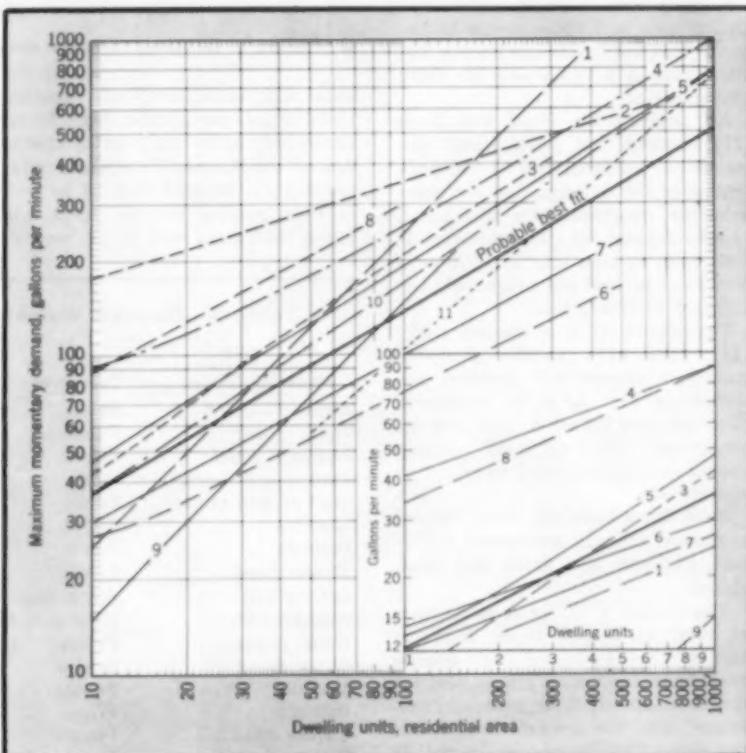
the year of minimum rainfall or about 60 percent of the average.

In any reservoir storage study it is important to take into consideration the probable losses due to evaporation from water surfaces during the year and during the warmer months. This becomes very significant in small systems when the water surfaces exceed 6 to 10 percent of the drainage area. Since evaporation varies greatly from place to place, local data should be obtained and utilized.

Peak Demand Estimates

The maximum hourly or peak demand flow, upon which to base the design of a water distribution system, should be determined for each situation. A small residential community, for example, would have characteristics different from a new

realty subdivision, central school or children's camp. Therefore, the design flow to determine distribution system capacity should reflect the pattern of living or operation, probable water usage, and demand of that particular type of establishment or community. At the same time, consideration should be given to the location of existing and future institutions, industrial areas, suburban or fringe areas, highways, shopping centers, schools, subdivisions and direction of growth. In this connection, reference to the city, town or regional "Comprehensive Plan" or "Master Plan," where available, can be very helpful. Generally, larger cities have a higher per capita water consumption than smaller cities; but smaller communities have higher percentage peak demand flow than larger communities.



From Environmental Sanitation by Joseph A. Salvato, Jr., published by John Wiley & Sons, Inc., New York, 1958.

● FIGURE 1. Probable maximum momentary water demand.

KEY TO DATA USED: (1) Maximum demand: $9 \times$ average daily annual flow; (2) Maximum demand: $100 + 25 (\text{no. dwel. units})^{1/2}$ (for less than 625 d.u., Calif.); (3) Fixture unit basis: Flush tanks, 1 bath, total 10 fixture units per house; (4) Flush valve system, A. P. Kuranz, "Studies on Maximum Momentary Demand," J. Am. Water Wks. Assoc., (Oct. 1942); (5) Flush tank system, Kuranz, (op. cit.); (6) Small house on small lot, very little lawn sprinkling, D. R. Taylor, "Design of Main Extensions of Small Size," Water & Sewage Wks. (July 1951); (7) Average 2-3 bedroom house, average lawn sprinkling, Taylor, (op. cit.); Fixture unit basis: 2-bath house, total 19 fixture units per house (peak); (9) Fixture unit basis: 2-bath house, 19 fixture units, average discharge; (10) Paul Campbell, Federal Housing Authority; (11) D. A. Root and T. R. Camp, "Equitable Charges for Fire Protection," Water & Sewage Wks., (June 1956).

Various bases have been used to estimate the probable peak demand. One assumption (8) for small water plants serving residential communities is to say that for all practical purposes, almost all water for domestic purposes is used in 12 hours. The maximum hourly rate is taken as twice the maximum daily rate, and the maximum daily rate is $1\frac{1}{2}$ times the average maximum monthly rate. If the average maximum monthly flow is $1\frac{1}{2}$ times the average monthly annual flow, then the maximum hour's consumption rate is 9 times the average daily flow rate.

Another basis (9) used on Long Island is: Maximum Daily Flow Rate = 4 times average daily flow rate; maximum 6-hour rate = 8 times average daily flow; and maximum 1-hour rate = $9\frac{1}{2}$ times average daily flow.

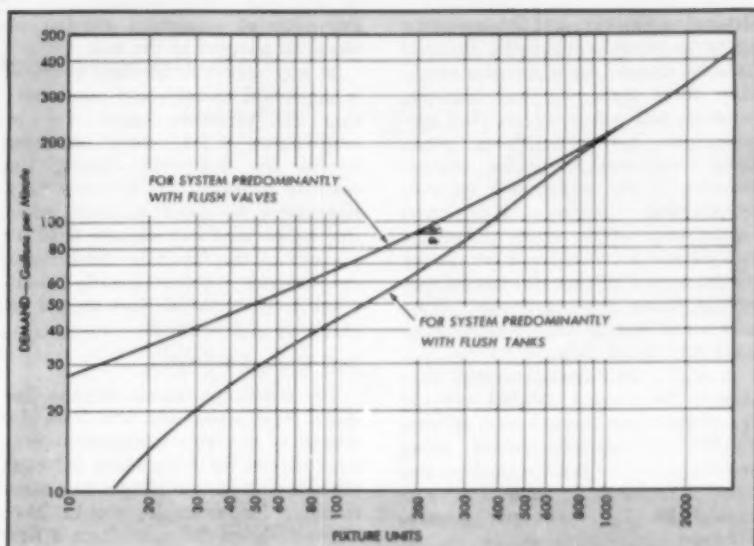
A study (10) of small water supply systems in Illinois seems to indicate that the maximum hourly demand rate is 6 times average daily consumption.

An analysis by Wolff and Loos (11) showed that peak water demands varied from 500 to 600 percent over the average day for older suburban neighborhoods with small lots; to 900 percent of neighborhoods with $\frac{1}{4}$ to $\frac{1}{2}$ -acre lots; to 1,500 percent for new and old neighborhoods with $\frac{1}{3}$ to 3-acre lots.

The results of a composite study (12) (13) (14) of the probable maximum momentary demand are shown in Fig. 1. It is cautioned, however, that for other than average conditions the required supply should be supplemented as might be appropriate.

Peak flows have also been studied at camps, schools, apartment buildings, highway rest areas and other places.

The design of water requirements at total road and super highway service areas introduces special considerations which are typical for the installation. It is generally assumed that the sewage flow equals the water flow. In one analysis (15) the extreme peak flow was estimated at 1,890 gpd per counter seat and 810 per table seat; but the peak day was taken as 630 gpd per counter seat and 270 gpd per table seat. In a study of national turnpike and highway restaurant experience (16), the flow was estimated at 350 gpd per counter seat plus 150 gpd per table seat. The flow was 200 percent of the daily average at noon and 160 percent of the daily average at 6 pm. It was concluded that ten percent of the cars passing a service



Adapted from Report of the Coordinating Committee for a National Plumbing Code, U. S. Department of Commerce, 1951.

● FIGURE 2. Estimated curves for demand load, flush tank and flush valve systems.

area will enter and will require 15 to 20 gal. per person. A performance study after one year of operation of the Kansas Turnpike service areas (17), showed that 20 percent of cars passing service areas will enter, that there will be $1\frac{1}{2}$ restau-

rant customers per car, that average water usage will be 10 gal. per restaurant customer of which 10 percent is in connection with gasoline service, and that plant flows may increase 4 to 5 times in a matter of seconds.

Table 3—Demand Weight of Fixtures in Fixture Units^a

Fixture or Group ^b	Occupancy	Type of Supply Control	Weight in Fixture Units ^c
Water closet	Public	Flush valve	10
Water closet	Public	Flush tank	5
Pedestal urinal	Public	Flush valve	10
Stall or wall urinal	Public	Flush valve	5
Stall or wall urinal	Public	Flush tank	3
Lavatory	Public	Faucet	2
Bathtub	Public	Faucet	4
Shower head	Public	Mixing valve	4
Service sink	Office, etc.	Faucet	3
Kitchen sink	Hotel or restaurant	Faucet	4
Water closet	Private	Flush valve	6
Water closet	Private	Flush tank	3
Lavatory	Private	Faucet	1
Bathtub	Private	Faucet	2
Shower head	Private	Mixing valve	2
Bathroom group	Private	Flush valve for closet	8
Bathroom group	Private	Flush tank for closet	6
Separate shower	Private	Mixing valve	2
Kitchen sink	Private	Faucet	2
Laundry trays (1 to 3)	Private	Faucet	3
Combination fixture	Private	Faucet	3

^aR. B. Hunter, Water-Distributing Systems for Buildings, National Bureau of Standards Building Materials and Structures Report BMS 79 (Nov. 1941).

^bFor supply outlets likely to impose continuous demands, estimate continuous supply separately and add to total demand for fixtures.

^cFor fixtures not listed, weights may be assumed by comparing the fixture to a listed one using water in similar quantities and at similar rates.

^dThe given weights are for total demand. For fixtures with both hot and cold water supplies, the weights for maximum separate demands may be taken as three-fourths the listed demand for supply.

It must be emphasized that actual meter readings from a similar-type establishment or community should be used whenever possible in preference to an estimate. Time spent to obtain this information is a good investment, as each installation has different characteristics. Hence the estimates and procedures mentioned here should be used as a guide to supplement specific studies and to aid in the application of informed engineering judgment.

Peak flows for apartment-type buildings can be estimated using the curves developed by Hunter (18). Fig. 2 and Table 3 can be used in applying this method. Additions should be made for continuous flows.

Distribution Storage Requirements

Water storage is necessary to help meet peak demands, fire requirements and industrial needs; and to maintain relatively uniform water pressures, to eliminate the necessity for continuous pumping, to make possible pumping when the electric rate is low and to use the most economical pipe sizes. The size and type of storage is determined by which of these specific factors or criteria are to be met. Other things being equal, a large diameter shallow tank is preferable to a deep tank of the same capacity. It is less expensive to construct and water pressure fluctuations on the distribution system are less. The cost of storage compared to the decreased cost of pumping, the increased fire protection and lowered fire insurance rate, the greater reliability of water supply and decreased probability of negative pressures in the distribution system will be factors in making a decision.

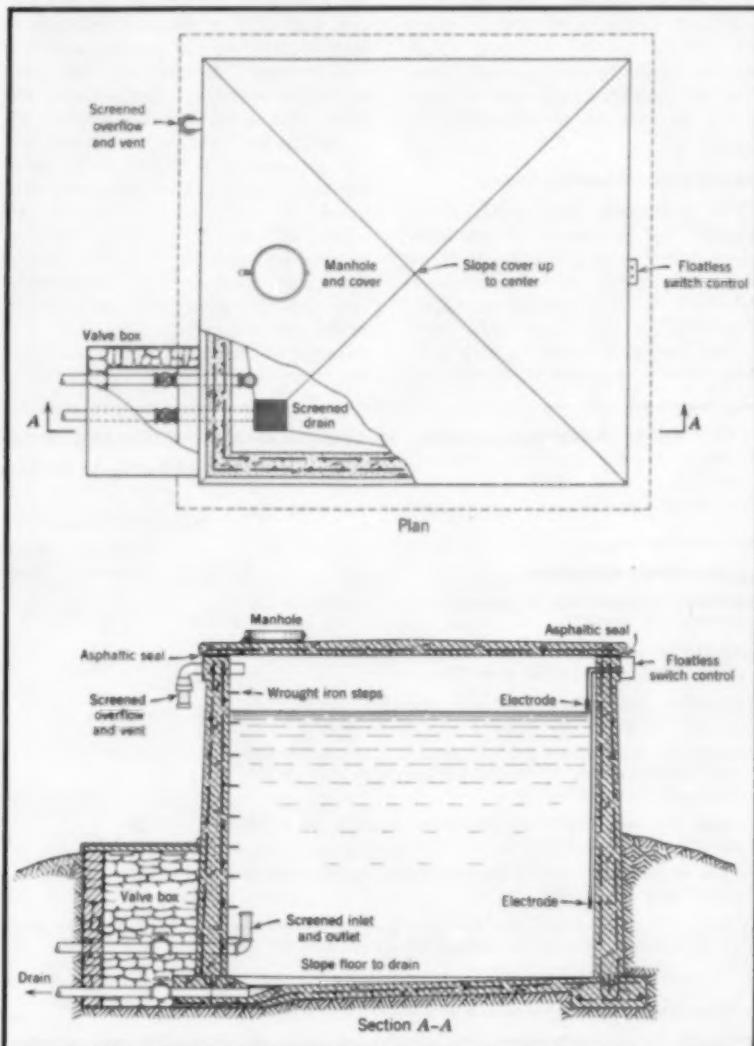
In general, it is recommended that water storage equal not less than one-half the total daily consumption, with at least one-half of the storage in elevated tanks. A preferred minimum storage capacity would be the maximum day usage plus fire requirements, less the daily capacity of the water plant and system for the fire flow period. In small communities, real estate subdivisions, institutions, camps and resort places, elevated storage should be equal to at least one full day's requirements during hot and dry months when lawn sprinkling is heavy. A 2 or 3-day storage is preferred. The amount of water required during peak hours of the day may equal 15 to 25 percent of the total maximum daily consumption. This amount in elevated storage will meet peak demands, but not fire re-

quirements. Some engineers provide storage equal to 20 to 40 gallons per capita or 25 to 50 percent of the total average daily water consumption.

It is good practice to locate elevated tanks near the area of greatest demand for water and on the side of town opposite which the main enters. Thus peak demands are satisfied with the least pressure loss and smallest main sizes. All distribution reservoirs should be covered; provided with an overflow which will not undermine the footing, foundation or adjacent structures; and provided with a drain, water level gage, access manhole with overlapping cover, ladder and screened air vent. The bottom of ground level reservoirs should be above the ground water table and

above any possible flood water level. In any case, sewers, septic tanks, tile fields, cesspools, manure piles, privies, drains or standing water should be at a lower elevation than the bottoms of reservoirs, at least 50 and preferably 100 feet away.

Steel standpipes, reservoirs and elevated tanks are made in a variety of sizes and shapes. As normally used, a standpipe is located at some high point to make available most of its contents by gravity flow and at adequate pressure; a reservoir provides mainly storage. The altitude of elevated tanks, standpipes and reservoirs is usually determined, dependent on topography, to meet special needs and requirements. Elevated tanks rising more than 150 ft. above the ground or located within 15,000 ft. of a



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● FIGURE 3. Construction details of a typical small concrete reservoir.

landing area, and in a 50-mile wide path of civil airways, must meet the requirements of the Civil Aeronautics Administration.

Pittsburgh-Des Moines Steel Co. manufactures various shape elevated tanks with capacities ranging upward from 10,000 gallons; Chicago Bridge and Iron Co. makes elevated tanks from 15,000 gallons capacity up; R. D. Cole Mfg. Co., from 5,000 gallons; Graver Tank and Mfg. Co., from 25,000 gallons; Darby Corporation, General American Transportation Corp., Nooter Corp. and Hammond Iron Works and others also supply tanks. Most of these firms also design, fabricate and erect standpipes and reservoirs. Reinforced prestressed concrete tanks are made by Preload. Wood tanks are made of cypress, redwood, fir and longleaf yellow pine. Wooden tanks are made in capacities from 125 gallons up by Caldwell and Federal. Properly designed and constructed wooden tanks can be expected to last 15 to 20 years or longer.

Fire Protection, Monetary Savings

For practically any small community, the provision of an adequate water system for fire protection will result in a significant reduction in fire insurance rates. The Grading Schedule (19) used by the National Board of Fire Underwriters is a means of classifying

cities, towns, villages or other municipal organizations with reference to their fire defenses and physical conditions. In arriving at an insurance rate, the schedule gives water supply in a community a weight of 34 percent, fire department 30 percent, fire alarm 11 percent, fire prevention 8 percent, structural conditions 14 percent, building department 4 percent and police department 1 percent; 32 different items are considered in evaluating the water supply. However, elaborate fire equipment can be given little credit if the water supply is inadequate and vice versa. Hence it is not practical to state categorically what the fire insurance rate would be in a community with a good water supply and what it would be in another with a poor water supply because there are gradations of good and bad and because of the other factors entering the grading system.

It is useful however to be able to make economic comparisons to show the need or desirability of adequate fire service. A hypothetical comparison is shown in Table 4 for this purpose. The designing engineer is encouraged to review his plans with the local rating bureau having jurisdiction so as to obtain the most favorable fire insurance rate for the particular community under consideration. The fire insurance savings reflected should, at the very least, be compared with

the additional cost in required water plant capacity and increased pipe size to provide fire protection, and the cost of money at the time of construction.

An example will serve to illustrate the value of a good public water supply and fire department to the individual home owner. The hypothetical residential fire insurance rates in Table 4 are used.

A frame dwelling upon which \$15,000 fire insurance is purchased would require an annual premium of $15,000 \times 0.10 + 100 = \15.00 . If the dwelling contents are insured for \$5,000, the annual premium would be $5,000 \times 0.16 + 100 = \8.00 , for a total of \$23.00 per year. This same dwelling in a community having an average fire department and a public water supply adequate only for domestic consumption, or having only individual wells, would have to pay an annual premium of 0.26 cent or \$39.00 on the dwelling and 0.32 cent or \$16.00 on the contents, a total of \$55.00 per year. Under the circumstances given, a home owner would be paying \$32.00 per year more for fire protection because the water supply was not adequate for fire fighting purposes. This \$32 per year from 500 homes will pay off a bond issue of \$238,000 in 20 years at 3 percent interest. This amount would pay the additional cost for such things as hydrants, larger pipes and storage for

Table 4—Representative Hypothetical Mercantile and Residential Fire Insurance Rates
Rates per \$100 Insurance Purchased per Annum

Community Description	Mercantile Property (a)				Residential Property (b)			
	Building	Business Contents	Dwelling Contents	Brick Structure		Frame Structure		
				Building Only	Contents Only	Building Only	Contents Only	
Good water system and fire department, and good overall community grading	\$.40	\$.88	\$.53	.08	.14	.10	.16	
Generally good water system and fire department, and good overall community grading	.48	.95	.58	.10	.16	.12	.18	
Poor water system and generally poor fire department, mainly fair construction and overall grading poor	.66	1.11	.70	.10	.16	.12	.18	
Average fire department (c), volunteer or paid, water system adequate for domestic consumption but inadequate for fire protection	1.17	1.29	1.17	.20	.25	.26	.32	
Average fire department (c), volunteer or paid, no water system, may use cisterns	1.21	1.33	1.21	.20	.25	.26	.32	
No fire department and no water system, no features of community protection	1.38	1.51	1.38	.32	.39	.39	.41	

(a) Assume 2-story buildings, wood floor joists, business store on first floor, dwelling unit on second floor. No deficiency charges taken for substandard roof, heating or chimney; no credit for fire extinguishers, etc.

(b) One to four-family occupancy.

(c) Fire department is not a factor because water supply is deficient.

NOTES: (1) An individually owned water system is not recognized but a private water company with responsible personnel is recognized. A seasonal water system is not recognized as a water system for year around insurance rate. (2) Where the water supply is considerably better than the fire department, or vice versa, the better feature cannot be utilized to full value. In recognition of this fact an additional deficiency is assigned where the divergence of these features is excessive.

fire protection, over a system designed only for domestic consumption.

Ground Water Sources

The sources of water supply are divided into major classifications; namely, ground water and surface water. To these should be added for completeness rain water and demineralized water. The ground-water supplies include dug, bored, driven and drilled wells, springs and infiltration galleries. The surface-water supplies include lake, pond, river and creek supplies.

In general, drilled wells are preferred for small water supplies where an adequate volume of satisfactory water is available. Special dug wells, infiltration galleries and driven wells are also very satisfactory where water-bearing formations are found and the available water has desirable characteristics. Gravel wall construction of wells provides a better yield in some instances, particularly where a fine water sand is encountered. The simplicity of operation and dependability when properly developed make such supplies particularly suitable where only part time non-professional operating personnel is available.

The proper location of wells with reference to probable sources of sewage and chemical pollution is dependent upon many factors. An excellent summary of studies and reports on the travel of pollution appeared in the October, 1957, issue of the *Journal of the AWWA*. Reference to that article will assist in the application of engineering judgment. The health department sanitary engineer should also be consulted.

Some basic considerations to protect the quality of a ground-water supply are brought out in *AWWA Standards for Deep Wells, A 100-58*. Sec. A1-11.1-General, is particularly pertinent. "In the construction of wells the intention should be to produce a safe water. This aim can normally be realized if, in selecting the well site, due consideration is given to possible sources of contamination in surrounding areas and proper heed is paid to casing the well as described in Sec. A1-5 and grouting and sealing the well as in Sec. A1-8. Only when a single available water-bearing formation lies so near the surface that it is continually contaminated is production of a safe supply not feasible."

The top of the finished well casing should terminate at least 18 in.

above the finished concrete floor around the well, above ground and above any possible flood level. At least two wells and an auxiliary source of power are recommended, and in some cases required, depending upon the available storage, frequency and duration of power failures, and availability of reliable pump service.

The consulting engineer should refer to AWWA A100-58 when preparing his plans and specifications for the construction of a deep well. Additional design criteria are given in *A Report of the Great Lakes-Upper Mississippi River Board of State Sanitary Engineers of Policies for the Review and Approval of Plans and Specifications for Public Water Supplies* normally available from the State Sanitary Engineer. To assure good well construction, it is important that a proper test is made for yield and drawdown, that well grouting and sealing are done effectively, that clean water is used in well drilling, that the well is properly developed and disinfected on completion, and that an accurate well log is obtained from the well driller.

It is often advisable to drill test wells to obtain an indication of the quantity of water available, depth to water, and the physical, chemical and bacterial quality of the water before a final decision is made. Laboratory examination of representative water samples from test wells will determine the need for treatment such as softening, iron removal, hydrogen sulfide removal and chlorination, and hence the suitability as well as total cost for

the intended purpose. The test wells should be filled with concrete or otherwise sealed so as to restore, as far as feasible, the controlling geological conditions that existed before the well was drilled. (See Sec. A1-13 Sealing Abandoned Wells, *AWWA Standard for Deep Wells, A100-58*).

Surface Water Sources

All surface water supplies are subject to intermittent pollution and must be treated to a greater or lesser degree to make them safe to drink. Additional treatment beyond safety, to make the water consistently attractive and acceptable, is usually needed. If elaborate treatment is needed, it would be best to abandon the idea of using a surface water supply and resort to a ground water supply if at all possible and practical. Where a surface water supply is used, a reservoir or lake that can be controlled and does not receive sewage or industrial waste pollution, would be preferred to a stream or creek, the pollution of which would be very difficult to control from a practical standpoint.

There are many situations where there is no practical alternative to the use of streams for water supply. In such cases carefully designed water treatment plants should be provided with full consideration and knowledge of the amount and degree of biological, chemical and physical pollution at times of average, low and high flows. This will require a map of the watershed showing streams, swamps, property boundaries and water surfaces; topography, types of vegetation, soil

Table 5—A Classification of Waters by Concentration of Coliform Bacteria and Treatment Required to Render the Water of Safe Sanitary Quality

Group	Maximum Permissible Average MPN No.	Coliform Bacteria per Month	Treatment Required
1	Not more than 10% of all 10-ml portions positive; approximately less than 2.2 coliform bacteria per 100 ml.		No treatment required of underground water, but a minimum of chlorination required of surface water.
2	Not more than 50 per 100 ml.		Simple chlorination or equivalent.
3	Not more than 5000 per 100 ml and this MPN exceeded in not more than 20% of samples.		Rapid sand filtration (including coagulation) or its equivalent plus continuous chlorination.
4	MPN greater than 5000 per 100 ml in more than 20% of samples and not exceeding 20,000 per 100 ml in more than 5% of the samples.		Auxiliary treatment such as 30-90 days storage, presettling, prechlorination, or equivalent plus complete filtration and chlorination.
5	MPN greater than 20,000 per 100 ml.		Prolonged storage or equivalent to bring within Groups 1-4.

types, dwellings and industries; land and stream uses and pollution classification; animal population; and roads. Such a map should be supplemented by an inspection and plans for watershed control.

Treatment Required

An indication of the degree of treatment water should receive, based upon the bacterial quality of the untreated water, is given by the Public Health Service (20). The classification is summarized in Table 5. As previously mentioned, for water to be generally acceptable, other treatment may be required in addition to that necessary for the elimination of disease-producing organisms. People expect the water to be safe, attractive to the senses, soft, non-staining and neither scale-forming nor corrosive to the water system.

It should be brought out again that the design of treatment facilities for small water plants must recognize, in addition to the amount and degree of pollution, the personnel available to control operation. Factors of safety should be built into the design to assure that a satisfactory water is produced in spite of carelessness or even negligence in operation. Generous pre- and post-chlorination capacity, longer detention periods, lower filtration rates, higher wash water rates, special slower opening filter valves, and alarm devices are some of the features that might be built into the basic design.

Intakes and Screens

Conditions to be taken into consideration in design of intakes include high and low water stages; navigation or allied hazards; floods, and storms; floating ice and debris; water velocities, surface and subsurface currents, channel flows and stratification; location of sanitary, industrial and storm sewer outlets; and prevailing wind direction.

Small communities cannot afford elaborate intake structures. A submerged intake crib, or one with several branches and upright tee fittings anchored in rock cribs 4 to 10 feet above the bottom, is relatively inexpensive. The inlet fittings should have a coarse strainer or screen with about one-inch mesh. The total area of the inlets should be at least twice the area of the intake pipe and should provide an inlet velocity less than 0.5 fps. Low entrance velocities reduce ice troubles and are less likely to draw in fish or debris. Sheet ice over the intake structure also helps avoid

anchor ice or frazil ice. If ice-clogging of intakes is anticipated, provision should be made for an emergency intake, or for injecting steam, hot water or compressed air at the intake. Back-flushing is another alternative which may be incorporated in the design. Fine screens at intakes will become clogged, hence they should not be used unless installed at accessible locations which will make regular cleaning a simple task. Duplicate stationary screens in the flow channel, with $\frac{1}{8}$ to $\frac{3}{8}$ -in. corrosion-resistant mesh can be purchased.

Some engineers have used slotted well screens in place of a submerged crib intake for small supplies. The screen is attached to the end of the intake conduit and mounted on a foundation to keep it off the bottom, and if desired crushed rock or gravel can be dumped over the screen. For example, a 10-ft. section of a 24-in. dia. screen made by Edward E. Johnson, Inc. with $\frac{1}{4}$ -in. openings is said to be able to handle 12 mgd at an influent velocity of less than 0.5 ft. per sec. Attachment to the foundation should be made in such a way that removal for inspection is possible.

In large installations, intakes with multiple-level inlet ports are provided in deep reservoirs, lakes or streams so as to make possible selection of the best water, when the water quality varies with the season of the year and weather conditions.

Micro-straining

Micro-straining is a process designed to reduce the suspended solids, including plankton, in a water. The filtering media consist of very finely woven fabrics of stainless steel on a revolving drum. Applications to water supplies are primarily 1) the clarification of relatively clean surface waters low in true color and colloidal turbidity, in which micro-straining and disinfection constitute the complete treatment; and 2) the clarification of waters ahead of slow or rapid sand filters to increase filter runs. Removals of the commoner types of algae have been as high as 95 percent. Wash water consumption may run from 1 to 3 percent of the flow through the unit. Blinding of the fabric rarely occurs but may do so, from inadequate wash water pressure or the presence of bacterial slimes. Cleansing is readily accomplished by means of commercial sodium hypochlorite (21). Small headlosses and low maintenance

costs may make the micro-strainer attractive for small installations.

There are four standard units, the smallest $2\frac{1}{2}$ ft. dia. x 2 ft. wide. This has a capacity varying between 50,000 and 250,000 gpd depending on the type and amount of solids in the water and the fabric used.

Chlorination

Chlorination is the most common method of disinfecting water for the purpose of destroying disease-producing organisms. The required chlorine dosage should take into consideration the amount and type of chemical, physical and organic pollution likely to be present and pretreatment given the water. Not to be forgotten are the type of microorganisms endemic to the area, the pH and temperature of the water and contact time. For example, Butterfield's (22) studies led to the practical recommendation that effective disinfection of a clear water can be achieved if a free chlorine residual of 0.2 mg/L is maintained in a water at a pH of 7.0 or less, 0.4 mg/L in a water at a pH of 8.0, and 0.8 mg/L in a water at a pH of 9.0 or 10.0. A combined chlorine residual after 60 minutes of 1.0 mg/L at a pH of 6.0, 1.5 mg/L at a pH of 7.0 and 1.8 mg/L at a pH of 8.0 is needed for equivalent disinfection. Partially purified poliomyelitis virus, will usually be inactivated in less than 2 hours by a free residual chlorine after 10 minutes of 0.05 mg/L at a pH of 6.85 to 7.4 and a residual chloramine value of 0.50 to 0.75 mg/L will usually inactivate the virus in less than 2 hours. (23) Destruction of the Coxsackie virus may require 7 to 46 times as much free chlorine as does *E. coli*. (24) Another study (25) reports that at 25°C and a pH value of 7.0, a concentration of at least 9.0 mg/L combined residual chlorine was necessary for inactivation of poliovirus with a contact period of 30 minutes, and 6 mg/L with a one-hour contact time. Infectious hepatitis virus was inactivated by coagulation, settling, filtration and chlorination to 1.1 mg/L total and 0.4 mg/L free chlorine. (26) Viruses have been isolated with considerable regularity from raw sewage and from stream samples 400 ft. below primary sewage treatment plant outfalls. Laboratory studies by Kelly and Sanderson on chlorination of sewage (29) "indicate that, depending on pH level and temperature, residual chlorine values of greater than 4 ppm with fifteen minutes contact, or contact periods of at least four hours with a residual

chlorine value of 0.5 ppm, are necessary to inactivate viruses, and that the recommended standard for disinfection of sewage by chlorine (0.5 residual after fifteen minutes contact) does not destroy viruses."

The tuberculosis organism in sewage has been reported to be destroyed by chlorination to a residual of 2 mg/L with a contact time of 30 minutes. A substantial reduction of tubercle bacilli was obtained by slow sand filtration. Others believe that a chlorine dose of at least 20 mg/L with a contact time of 2 hours is needed to disinfect adequately a biologically treated sewage effluent containing tubercle bacilli. The Pathogenic fungus *Histoplasma capsulatum* can be expected in surface water supplies, in treated water stored in open reservoirs and in improperly protected well water supplies. Fungicidal action is obtained at a pH of 7.4 and at a water temperature of 26°C with 0.35 mg/L free chlorine after four hours contact and with 1.8 mg/L free chlorine after 35 minutes contact. Complete rapid sand filter treatment completely removed all viable spores even before chlorination. (28) Where a surface water supply is chlorinated only, the chlorine dosage should provide at least the free chlorine residual and contact time indicated by Metzler and his co-workers. Where a known sewage polluted surface water supply is to be used, the treatment must also assure removal and destruction of protozoal and viral microorganisms.

In any recommendation for chlorination it should be recognized that bacterial control of the water in a distribution system, particularly an old system or one that has growths or incrustations in the pipe, may be lost unless a free residual chlorine (at least 0.2 to 0.4 mg/L) is maintained in all active parts of the distribution system. Chlorinator capacities therefore may, in some instances, be determined by the dosage needed to accomplish this objective. Treatment proportional to water flow can be obtained by any of several devices. It is especially desirable in small supplies.

In the treatment of a surface water supply, the chlorinator should have a capacity to pre-chlorinate at 20 mg/L or more and post-chlorinate at 3 mg/L A capacity of 3 mg/L is suitable for the disinfection of ground water supplies; but more is needed for carrying a free chlorine residual in a distribution system and for special treatment, such as iron or hydrogen sulfide removal.

Commercial equipment for adding hypochlorite solution includes the orifice box type with or without a pump; the timed solution drawoff pipe with pump; the diaphragm or displacement pump; the displacement pressure storage tank; the venturi feeder; and the calcium hypochlorite tablet feeder. The positive-feed type of hypochlorinator is usually preferred. Hypochlorinators are available in sizes to feed from 15 gallons or less to several hundred gallons per 24 hours. The positive-feed displacement type hypochlorinators will operate against water pressures up to 150 psi and the piston type up to 500 psi. Feeders are also available with several heads to permit feeding several solutions at the same time.

Positive-feed solution feeders are manufactured by Precision Chemical Pump Corp.; Bruner Corporation; B-I-F Industries; Wallace & Tiernan Inc.; Chloromeric Co.; Fischer & Porter; Klenzade Products; Permutit Division; Lapp Insulator Company, Inc.; Manzel; and others. Prices of the smallest feeders vary from approximately \$100 to \$270 or more depending on feed pump capacity and maximum pumping pressure.

Chlorine gas feeders fall into two general groups, the direct- or dry-feed chlorinator and the solution pressure- and vacuum-feed chlorinator.

The solution vacuum-feed chlorinator is the safest and most common type. On the other hand, where water under pressure is not available or is dependent upon electric pumps, the electric power for which is not dependable, the direct-feed chlorinator should receive careful consideration for small installations, particularly if a standby generator is not provided. However, the V-notch type of solution feed chlorinator made by Wallace and Tiernan Inc. does not require an auxiliary water supply under pressure.

The temperature of the water to the chlorinator should be above 50°F. In cold climates, where surface water is used to operate the chlorinator, provision should be made to warm the water before it reaches the chlorinator. Running the water line around a heated room, using a thermostatically controlled electric strip or line heater or placing a water storage tank in a heated space are possible methods.

It would be ideal if a residual chlorine recorder and dosage controller were installed to maintain and record a pre-determined range or level of free residual chlorine in

the treated water, with an alarm unit to report a variation from the established range. In any case, a water sampling tap is needed at some point where a well-mixed sample can be collected to control and adjust the chlorine dosage. In addition, it is necessary to make conveniently possible collection of a water sample after a 20-minute contact time when the sole treatment is chlorination.

Gas feed chlorinators should be located in gas-tight rooms which are isolated from other work rooms or spaces. Chlorine cylinders supplying the chlorinators are preferably located in another gas-tight room although this may be impractical in small water plants. In any case, it should be possible to ventilate the rooms to a safe place in case of chlorine leakage. A louvered direct opening or duct taking off at the floor, equipped with an exhaust fan which provides a room air change every 3 minutes, and a fresh-air intake, will make possible rapid removal of chlorine in case of leakage. The outside door to the chlorinator and chlorine cylinder rooms should have a glass inspection panel. A chlorine gas mask should be readily available outside the rooms and the exhaust fan switch should also be outside.

The chlorinator room should be heated by a hot water radiator, stove or electric heater where needed to maintain the air temperature at 60° to 70°F. A platform scale is necessary to weigh chlorine cylinders in use to determine the pounds of chlorine used each day and to anticipate when new cylinders will be needed. The scale should be recessed in the floor, with the platform level with the floor. Chlorine cylinders should be connected to a manifold so that chlorine may be drawn from two or more cylinders at a time, if the chlorine usage exceeds 30 pounds per day when using 100 pound cylinders and 40 pounds per day when using 150 pound cylinders, and so that cylinders can be replaced without interrupting chlorination.

A residual chlorine testing kit, or amperometric titrator, is essential with which to control chlorination. On gravity-flow water systems, in which the operation of the chlorinator water supply is dependent upon uninterrupted electric power, a standby generator is needed to cut in automatically in case of power failure.

Chlorinators are manufactured by B-I-F Industries, Inc.; Fischer & Porter; Everson Manufacturing Co.;

and Wallace & Tiernan. Machines are available to feed accurately as little as a few pounds per 24 hours. Where the safety of a water supply depends upon continuous chlorination treatment, a duplicate chlorinator and duplicate water booster pump where needed for a solution-feed chlorinator, are essential, in addition to standby power.

This article is aimed primarily at small water plants serving 15,000 to 200,000 gpd or operating at a rate of 60,000 to 800,000 gpd with 6-hour operation per day. The use of a gas chlorinator, which requires a separate ventilated room, platform scale, perhaps a suitable water supply at adequate volume and pressure, and a gas mask, can usually be more easily justified when the chlorine consumption exceeds 1½ to 2 pounds per day.

For example: Assume that the cost of 12 percent sodium hypochlorite is 40 cents per gallon (approximately one pound of chlorine) and chlorine gas (liquid) in 100 or 150-pound cylinders costs 12 cents per pound. Assume a hypochlorinator installed sells for \$350 and a small gas chlorinator for \$950. A water supply of 60,000 gpd is chlorinated at the rate of 2½ mg/L, thereby requiring 1¼ lb./day of chlorine or 456 lb./yr.

Assume the life of a hypochlorinator is 20 years; a gas chlorinator 10 yrs.; a water pump, heater, gas mask, and platform scale 10 yrs.; and a separate building to house a gas chlorinator 20 yrs. Money can be borrowed at 3½ percent. Maintenance and repairs are assumed to be the same.

Total annual cost of the hypochlorinator and the gas chlorinator may be computed by use of the equation shown in the box at the right. Using the costs and durations of useful life assumed in the paragraphs above, and neglecting the costs of repair, which are assumed to be the same for each type of unit, it will be found that a hypochlorinator with a salvage value of \$50 will have an annual cost of \$205.26. Similarly, for a gas chlorinator with a salvage value of \$100; a water pump, gas mask, platform scale, water and electrical connections costing \$400 (life 10 years); and a separate building costing \$500 (life 20 years), the total annual cost will amount to \$243.77.

If the cost of money is 5 percent, the annual cost of the hypochlorinator installation would be \$208.97 and gas chlorinator \$261.72. In this example, when the chlorine consumption is somewhat over 1½

EQUATION FOR COMPUTATION OF TOTAL ANNUAL COST

$$S_i = C_i + O = i \frac{(C - \text{salvage})}{(1+i)^n - 1} + \frac{R_i}{(1+i)^x - 1}$$

where

S_i = total annual cost

C = first cost

O = operating cost

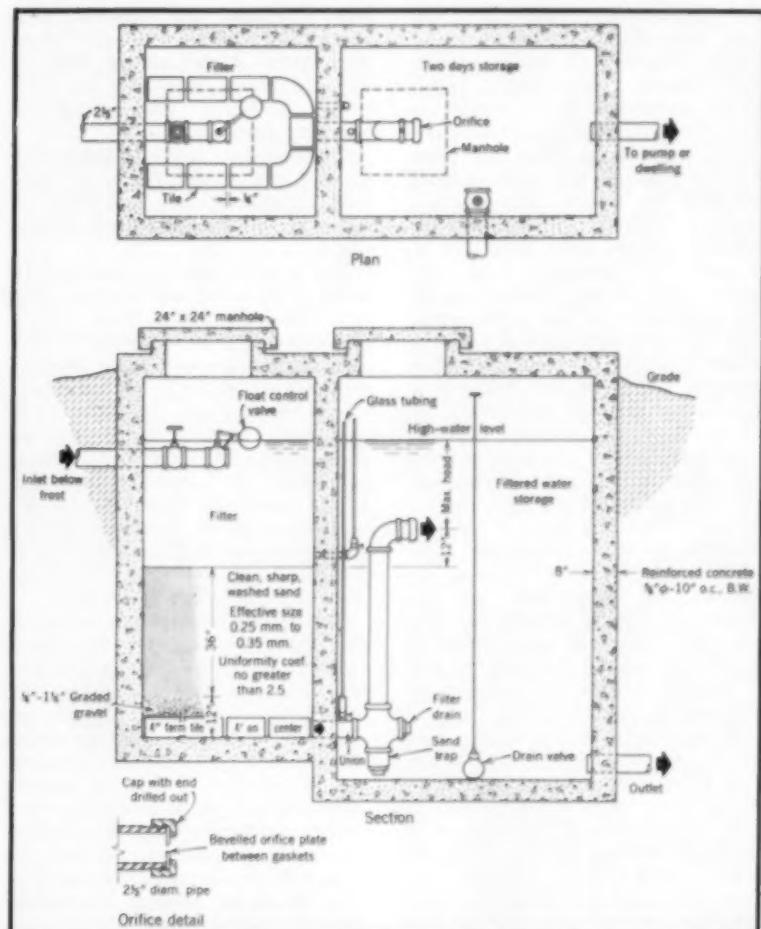
C_i

$\frac{(1+i)^n - 1}{(1+i)^x - 1}$ = annual rate of depreciation or money set aside each year at compound interest i to equal first cost C at the end of n years

$\frac{R_i}{(1+i)^x - 1}$ = major repairs every x years

lb./day, the annual cost of the hypochlorinator and gas chlorinator installation are about the same. There will of course be local and individual variations. In general, the quantity of chlorine used, local cost of chlorine and sodium hypo-

chlorite, useful life of the machine, need for a new building, water pump and scales are critical determinants. If calcium hypochlorite is considered in place of sodium hypochlorite then another basis of comparison can be established.



From *Environmental Sanitation* by Joseph A. Salvato, Jr., published by John Wiley & Sons, Inc., New York, 1958.

● FIGURE 4. Arrangement of a slow sand filter for a small water supply.

Filtration

Filters are of the slow sand, rapid sand, and pressure (or vacuum) type. The primary purpose of filters is to remove suspended particles, bacteria and other undesirable microorganisms. The slow sand filter is recommended for use at resort and rural places, where adaptable. A rapid sand filter is recommended only when competent supervision and operation, including laboratory control, can be assured. The pressure filter, including the diatomaceous earth type, is commonly used for industrial water supplies, swimming pool water, water for beverage and ice plants, clean drinking water supplies not subject to significant contamination (maximum permissible average MPN of coliform bacteria per month less than 50 per 100 ml.) and for iron and manganese removal. Pressure filters are not recommended for the treatment of water subject to significant contamination which is to be used for drinking purposes, except under emergency carefully controlled conditions.

Slow Sand Filters

From a practical standpoint, the water to be filtered should be relatively clear, with a turbidity of less than 30 mg/L, otherwise the filter tends to clog quickly. A plain sedimentation basin ahead of the filter can be used to reduce turbidity, if necessary. Microscopic organisms in large numbers, such as algae, lead to short filter runs. If colloidal clay is present in the raw water, some will pass through a slow sand filter and some will be retained in the filter eventually causing internal clogging. Coagulation and rapid sand filtration would be indicated in such cases. Some design criteria are given in Table 6.

A well-operated slow sand filter will remove protozoa such as *Endamoeba histolytica* and helminths such as *Schistosoma haematobium* and *Ascaris lumbricoides*, as well as 98 to 99.5 percent of the bacteria in the raw water. Chlorination of the filtered water is necessary. This type plant will also remove about 25 to 40 percent of the color in the untreated water. Chlorination of the sand filter itself is desirable either continuously or periodically to destroy bacteria that grow within the sand bed, the supporting gravel or the underdrain system. Continuous prechlorination at a dosage to provide 0.3 to 0.5 mg/L in the water on top of the filter will not harm the filter film.

Table 6—Some Design Features of Slow and Rapid Sand Filters

(Adapted from Ten-State Standards, January, 1953.)

SLOW SAND FILTER DESIGN

At least two units; covered where heavy freezing expected; provide 6 ft. head room.

Filter rate 2 to 6 mgd/acre; provide valve and flow measuring device on each filter effluent line.

Curb or equivalent around filters and filtered water storage.

Lateral underdrains spaced not more than 10 ft.

Maximum velocity in underdrains 0.75 fps. Make drain 4 in. diameter to drain filter area of 260 sq. ft., 5 in. diameter for 420 sq. ft., and 6 in. diameter for 600 sq. ft.

Design for water depth over sand of 3 to 5 ft.

Portable sand ejectors operated by water under pressure.

Prevent scour of sand surface by incoming water.

Control inflow to prevent flooding, and provide for filling filter after cleaning without cross-connection.

No connections with sewers or other improper cross-connection.

Keep gravel layer at least 2 ft. from filter side walls; carry sand to bottom.

Sand effective size 0.25 to 0.35 mm and uniformity coefficient of 2.5 or less.

Gravel minimum depth and size:

Minimum depth	Passing	Retained
6 in.	3 in. diam. screen	1 in. diam. screen
2 in.	1 in. diam. screen	3/8 in. diam. screen
2 in.	1/2 in. diam. screen	3/16 in. diam. screen

RAPID SAND FILTER DESIGN

At least two units.

Filter rate 2 gpm/sq. ft.

Water level in filter at least 8 ft. higher than clear well water level.

Overflow in filters to prevent water flow over filter walls.

Water level in filters lower than filter operating floor.

Curb or equivalent around filters and clear well.

Velocity in filter influent pipe not greater than 2 fps, in effluent pipe 3 to 4 fps, in wash-water supply pipe not greater than 10 fps, in wash-water sewer up to 10 fps.

Wash-water troughs spaced so that suspended solids need travel not more than 3 ft.

Sand effective size 0.35 to 0.50 mm and uniformity coefficient of 2.0 or less.

Larger effective size sand up to 0.80 mm used only under certain conditions.

A 3-inch layer of torpedo sand (E.S. 0.80 to 2.0 mm, U.C. 1.7) is desirable over gravel to support sand.

Design loss head in manifold and laterals as nil.

Cross-sectional area of manifold is 1 1/2 to 2 times total area of the laterals; wash-water velocity not more than 8 fps, preferably 6 fps in manifold.

Ratio of total area of orifices or strainers in laterals to filter area is about 0.003, orifices 1/4 to 1/2 in. diameter spaced 3 to 8 in.

Total cross-sectional area of lateral is about twice total area of final openings; velocity in lateral not greater than 6 fps, laterals spaced 6 to 12 in. on centers and length not more than 60 diameters.

Surface wash is desirable; provide water pressure of 45 to 75 psi and vacuum breaker.

No connections with sewers or other improper cross-connection.

Design wash-water rate to give 40 to 50 percent sand expansion.

Wash-water storage tank provides at least 10 minutes wash water for one filter.

Not less than four layers of gravel:

Range	Depth
2 1/2 to 1 1/2 in.	5 to 8 in.
1 1/2 to 3/4 in.	3 to 5 in.
3/4 to 1/2 in.	3 to 5 in.
1/2 to 3/16 in.	2 to 3 in.
3/16 to 3/32 in.	2 to 3 in.

Table 7—Frictional Head in Feet in Compacted Sand One Foot Thick, at a Temperature of 50°F.*

Size of Sand, in mm (a)	Rate of Filtration, mgd/acre				
	1	2	3	4	5
.15	.052	.104	.156	.208	.260
.20	.030	.060	.090	.120	.150
.25	.019	.038	.056	.075	.094
.30	.013	.026	.039	.052	.065
.35	.010	.019	.029	.034	.048
.40	.007	.014	.022	.029	.037

*Adopted from Turneaure and Russell, *Public Water Supplies*, John Wiley & Sons, Inc., New York, 1914.

(a) Effective size.

NOTES: (1) The loss head at 40°F is 20 percent higher, at 60°F about 14 percent lower, and at 70°F 25 percent lower than the above figures.

(2) After a filter has been in use for some time the loss head after cleaning will gradually increase to several times these figures.

Although slow sand filters are used in large as well as small water plants, their greatest usefulness is at small water plants, and at plants where competent technical supervision and operation cannot be assured or is not available. In arriving at a dividing line between a slow sand filter plant and a rapid sand filter plant, aside from the limitations already mentioned, the following should be considered:

1) The smallest commercially available rate controller has a minimum capacity of about 50,000 to 60,000 gpd.

2) The smallest conventional prefabricated complete gravity rapid sand filter plants have minimum capacities of 21,600, 43,200 and 72,000 gpd at normal operating rates. With a minimum of two units, this would correspond to 43,200 to 144,000 gpd.

3) If a criterion in rapid sand filter design is that the maximum horizontal travel of suspended parti-

cles to reach a wash-water trough in backwashing a filter is not more than 3 feet (it could of course be less) then the filter should have a maximum radius of about 3 feet. Such a filter would have a surface area of 28.26 sq. ft. and filter 56.5 gpm per sq. ft. A minimum of two units should be provided.

4) Flash mixers and coagulators are made to handle as little as 15,000 gpd. Equipment for clarifiers is as small as 10 ft. in diameter.

A slow sand filter consists of a watertight basin, usually covered, built of concrete. The basin holds a sand bed 30 to 48 in. deep which is supported on a 12-in. layer of graded gravel placed over an under-drain system which may consist of open joint, porous or perforated pipe or terra cotta tile. The sand should have an effective size of 0.25 to 0.35 mm. and a uniformity coefficient of about 1.75. Some health authorities permit a uniformity co-

efficient no greater than 2.5. Operation of the filter at a small water plant is controlled so that filtration will take place at a rate not exceeding 4 mgd/acre with 2½ mgd/acre as an average rate. This would correspond to a maximum filter rate of 92 gpd/sq. ft. of sand area, or an average rate of 57 gpd/sq. ft. A higher rate may be used where the water has received effective pre-treatment. A loss of head gauge should be provided on each filter unit to show the resistance the sand bed offers to the flow of water through it and to show when the filter needs cleaning. Since cleaning requires some time, two filters should be provided unless storage is large. The sand depth should not be permitted to fall below 24 in.

Slow sand filters are designed to operate with a 3 to 5-ft. head of water over the sand. When the head loss approaches within about 6 in. of the depth of water over the sand, the filters should be cleaned.

A slow sand filter suitable for a small water supply is shown in Fig. 4. Details relating to a simple design are given in Table 6. The rate of filtration in this filter is controlled by selecting an orifice and filter area that will deliver not more than 50 gpd/sq. ft. of filter area and thus prevent excessive rates of filtration that would endanger the quality of the treated water.

For example: Find the size filter and orifice which will deliver 50,000 gpd. Assume the sand has an effective size of 0.35 mm and a depth of 3 ft.; the filter rate is 2mgd/acre (46 gpd/sq. ft.) and water temperature average 50°F.

From Table 7, it can be seen that the head loss through the sand is

Table 8—Flows from Orifices under Various Heads of Water*

Maximum Head; inches of water over center of orifice	Diameter of Orifice, in inches																	
	1/4	5/16	3/8	1/2	5/8	3/4	7/8	1 1/16	1 1/4	1 1/2	1 3/4	1 7/8	2 1/16	2 1/4	2 3/8	2 7/16	3 1/8	3 7/16
2	430	675	980	1330	1730	2190	2710	3280	3900	5200	6920	8770	10,820	13,100	15,500	18,300	21,200	27,800
4	610	950	1380	1870	2450	3100	3830	4640	5520	7500	9800	12,400	15,250	18,560	22,000	25,900	29,900	39,200
6	750	1170	1690	2290	3000	3800	4990	5670	6760	9200	12,000	15,250	16,700	22,700	27,100	31,700	36,700	47,900
8	865	1350	1950	2640	3480	4400	5420	6550	7800	10,600	13,870	17,560	21,600	26,200	31,200	36,600	42,500	55,500
10	970	1510	2190	2960	3880	4900	6050	7320	8710	11,850	15,500	19,600	24,200	29,300	34,800	40,900	47,500	61,900
12	1060	1660	2390	3240	4250	5360	6620	8020	9540	13,000	17,000	21,400	26,400	32,100	36,100	44,800	52,000	68,000
16	1305	2040	2930	3900	5220	6880	8130	9850	11,700	15,950	20,800	26,400	32,600	39,400	47,800	55,000	63,900	83,500
24	1520	2370	3410	4650	6060	7880	9480	11,480	14,300	18,600	24,210	30,500	37,600	45,400	55,200	62,400	73,600	96,200
36	1660	2620	3780	5150	6720	8500	10,500	12,680	15,100	20,600	26,800	34,100	42,000	50,700	61,600	69,700	82,400	107,500
48	1840	2880	4140	5640	7380	9130	11,520	13,920	16,550	22,600	29,500	37,300	46,000	55,600	67,500	76,500	90,200	118,000
64	1990	3100	4470	6060	7950	10,050	12,420	14,900	17,900	24,300	30,700	40,200	49,700	60,000	73,000	82,600	97,500	127,000
84	2125	3330	4790	6530	8520	10,800	13,300	16,100	19,150	26,100	34,000	43,100	53,200	64,400	78,000	88,400	104,200	136,000
96	2290	3580	5160	7020	9150	11,600	14,350	17,300	20,600	28,000	36,600	45,600	55,200	68,100	82,600	93,500	110,300	144,000
66	2370	3700	5340	7260	9480	12,000	14,800	17,960	21,400	29,000	38,700	48,700	59,500	72,000	87,400	100,800	116,800	150,200
72	2490	3890	5600	7620	9960	12,600	15,550	18,850	22,400	30,500	39,300	50,400	62,200	75,300	91,400	103,400	122,000	159,300
	2600	4070	5850	7980	10,400	13,150	16,250	19,900	23,400	31,800	41,500	52,700	66,200	78,700	95,500	110,200	127,800	167,000

Flow is based on $Q = C_d V A$, where $V = \sqrt{2gh}$ and $C_d = 0.6$ with free discharge.

0.019 ft., or through 3 ft. the total loss head would be 0.057 ft. or 0.68 in. Since the head loss gradually builds up after cleaning, for design purposes the head loss through the sand and drain for initial operation will approach 6 in. From Table 8, a 1 1/4-in. orifice under a head of 36 in. (30 in. water plus 6 in. head loss) will deliver a maximum quantity of about 55,600 gpd.

The filter area required would be: $55,600 \text{ gpd} / 46 \text{ gpd/sq. ft.} = 1,210 \text{ sq. ft.}$ At least 2 filters should be provided.

Where competent and trained personnel are available, the rate of flow can be controlled by operating a gate valve on the effluent line from each filter. A venturi, orifice, weir or other suitable meter, with manometer or other indicating and preferably recording instruments, must be installed to measure the rate of flow. The valve can be adjusted to give the desired controlled rate of filtration, until the valve is wide open, which would indicate the filter needs cleaning.

Automatic filtration control can be obtained by installing a float-controlled valve on the filter effluent line as shown in Fig. 5. The valve is actuated by the water level in a float chamber, which is constructed to maintain a reasonably constant head over an orifice or weir in the float chamber.

For example: Find the orifice which will deliver 50,000 gpd. Assume a filter rate of 2 mgd/acre.

From Table 8, a 1 1/4-in. orifice under a 3.5-ft. head, a 1 1/4-in. orifice under a 2.5-ft. head and a 1 1/2-in. orifice under a 1.8-ft. head will meet the requirements.

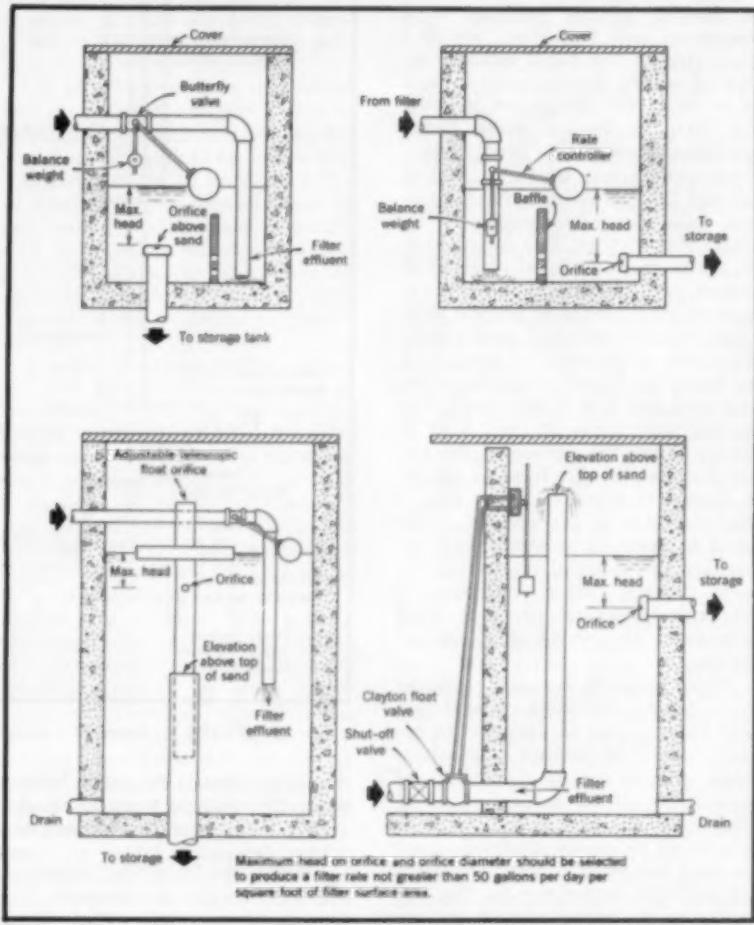
A special rate-control valve can also be used if the plant rate of flow is within the limits of accuracy of the rate controller. A commercially available 3-inch venturi-type rate of flow controller has a minimum capacity of about 50,000 to 60,000 gpd.

Rapid Sand Filters

Fig. 6 shows a flow diagram of a rapid sand filter plant. Essential elements of rapid sand gravity filters are shown in Fig. 7. Two important accessories to a rapid sand filter are the rate of flow controller and the loss of head gauge. The flow controller maintains the desired constant rate of filtration through the sand bed, usually 2 gpm/sq. ft. The loss of head gauge shows the increasing frictional resistance to the flow of water through the sand, manifold, underdrain system and piping.

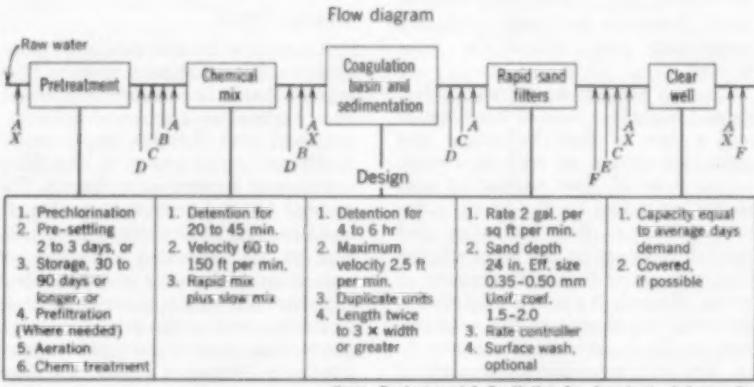
The rate of filtration is usually 125 mgd/acre of sand area, which is equal to 2870 gpd/sq. ft. or 2 gpm/sq. ft. A filter rate of 3 gpm/sq. ft. may be permitted with skilled

operation, if pretreatment can assure water on the filter with a turbidity of less than about 10 mg/l and a coliform concentration of less than 2.2. Sand for the higher rate



From: *Environmental Sanitation*, by Joseph A. Salvato, Jr., published by John Wiley & Sons, Inc., New York, 1964.

● FIGURE 5. Typical devices for the control of the rate of flow or filtration.



From: *Environmental Sanitation*, by Joseph A. Salvato, Jr., published by John Wiley & Sons, Inc., New York, 1964.

● FIGURE 6. Rapid sand filter flow diagram and points of chemical application.
KEY TO ALTERNATIVE CHEMICAL COMBINATIONS: A, chlorine; B, coagulant; C, alkalinity adjustment; D, activated carbon; E, dechlorination; F, fluoridation; X, carbon dioxide.

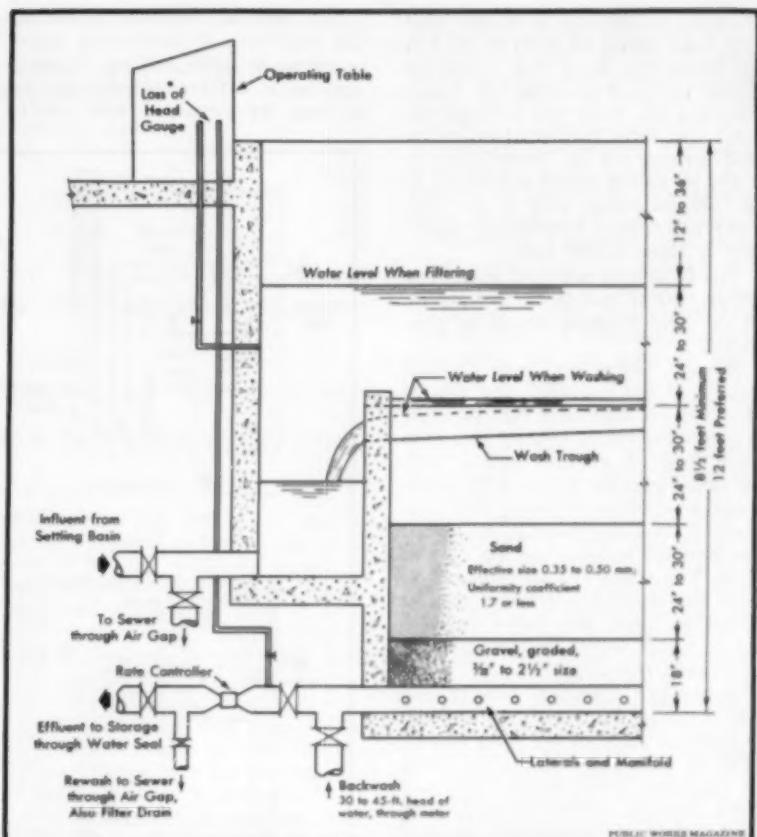
may have an effective size of 0.5 to 0.8 mm. and a uniformity coefficient of 1.5 to 2.0, if permitted.

Treatment of the raw water by coagulation and settling, and usually chlorination, to remove as much as possible of the pollution is a necessary and important preliminary step in the rapid sand filtration of water. Special arrangement is made in the design for washing the filter by forcing water backwards up through the filter underdrain system and sand at a rate of around 15 to 30 gpm/sq. ft. of sandbed area, depending primarily on water temperature. This corresponds to a rise in water level of 24 to 48 inches per minute. A wash water rate which provides 50 percent sand expansion is considered good design. The dirty wash water is carried off to waste by troughs built in above the sand bed 5 to 6 feet apart. The trough weir lip is at least 6 to 10 inches above the surface of the expanded filter media. In some plants, a system of rakes or water jets is also provided at the surface of the sand to assist in loosening and removing the material on and in the sand. Surface wash is recommended particularly where adequate sand expansion is not obtained at all times.

When properly operated, a filtration plant, including coagulation and settling, can be expected to remove about 98 percent of the bacteria, a great deal of the color, and practically all the suspended solids. Nevertheless, chlorination must be employed to assure that the water leaving the plant is safe. The MPN of coliform organisms in the raw water to be treated should not exceed that listed in Table 5, unless the water is brought within the permissible limits by preliminary treatment, and other microorganisms, chemicals and taste producing compounds are effectively controlled.

Control equipment on each filter should include a loss-of-head gauge and a rate of flow indicating and recording gauge, as well as a wash water rate of flow indicating and recording gauge on the wash water line. A rate of flow indicating and recording gauge on the plant effluent line will show the total amount of water filtered. As previously stated, the smallest commercially available rate of flow controllers are the 3-in. size with a minimum capacity of 50,000 to 60,000 gpd. Venturi type rate of flow indicators come as small as 1-in. size.

Gravity filters are built in wood or steel tanks or concrete basins by



● FIGURE 7. Essential elements of a conventional rapid sand filter.

American Water Softener, Roberts Filter Co., Infilco, Norwood Engineering Co., Permutit Division and others. Operating tables are made by Infilco, Foxboro Co., Builders-Providence, F. B. Leopold Co., Roberts Filter Mfg. Co., Bailey Meter Co., Permutit Div., Simplex Valve & Meter Co., Filtration Equipment Corp. and others.

Pressure Filters

A pressure filter is similar in principle to the rapid sand gravity type except that it is completely enclosed in a vertical or horizontal cylindrical steel tank through which water is filtered under pressure. The filter media may be sand or anthrafil. The normal filtration rate is 2 gpm/sq. ft. of filter area. Backwashing is accomplished by reversing the flow of water, using the same pump as when filtering. The rate is therefore usually determined by the pump capacity. Surface wash arrangements are also available. Pressure filters are most frequently used in swimming pool, beverage plant, ice plant, food plant and industrial installations primarily for water clarification and conditioning. They are also used in con-

nexion with iron and manganese removal (not more than 2 mg/L Fe and Mn), suspended solids removal following lime-soda treatment, and with zeolite softeners. It is possible to use only one pump to take water from the source or out of the pool and force the water through the filter directly into the water system or back into the pool. This is the main advantage of a pressure filter. The advantage is offset by the difficulty in introducing chemicals under pressure, inadequate coagulation facilities, and lack of adequate settling. The appearance of the water being filtered and the condition of the sand cannot be seen; the effectiveness of backwashing cannot be observed; and the safe filtration rate may be exceeded. It is difficult to look inside the filter for the purpose of determining loss of media, determining the need for cleaning or replacing it and for inspecting the wash water pipes, influent and effluent arrangements. Because of these factors, a pressure filter is not considered dependable for the treatment of contaminated water to be used for drinking purposes. It may, however, have limited application for slightly

contaminated, turbid water supplies. In such cases the coagulant should be well mixed and the water settled in a basin open for inspection before being pumped through a pressure filter. This will normally require double pumping.

Pressure filters are available through many manufacturers including General Filter, Cochrane, Roberts, Hungerford & Terry, Permutit, Infilco, American Water Softener and most manufacturers of swimming pool filtration equipment.

Diatomite Filters

The diatomaceous earth filter was developed during World War II to meet the need for a lightweight, small, high capacity water filter which would remove most types of microorganisms likely to be encountered. It was found that neither the pressure sand filter nor the rapid sand filter could be depended upon to remove all of the amebic cysts and the cercaria causing schistosomiasis.

The original filters consisted of closed steel cylinders inside of which were suspended several filter elements to support the diatomaceous earth. Many variations have been devised. Normal rates of filtration are 1 to 2 gpm/sq. ft. of filter element surface area, although manufacturers sometimes recommend higher rates. To prepare the filter for use, a slurry of filter aid or diatomaceous earth, known as precoat, is introduced with the water to be treated at a rate of about 1½ oz. per sq. ft. of filter septum surface area. Then, additional filter aid, the body coat, is added with the water to maintain the permeability of the filter mat. The rate of feed is roughly 2 to 3 mg/L per mg/L of turbidity in the water. Filter aid, which comes in different particle sizes, forms a coating or mat around the outside of each filter element and is more efficient than sand in removing from water suspended matter and such organisms as cysts which cause amebiasis, and worms which cause ascariasis and trichuriasis. However, these organisms, except for amebic cysts, and possibly schistosomes, are not common in the United States.

Like the pressure filter, the diatomite filter has found greatest practical application in swimming pools, food and industrial installations and by the military. The floor area requirement is much less than for a pressure sand filter. A 36-in. diameter diatomite filter will provide the same filtering area as two 96-in. diameter sand filters. No chemical coagulant is used.

The filter is usually backwashed by reversing the flow of the filtered water back through the septum, thereby forcing all of the diatomite to fall to the bottom of the filter shell from which point it is flushed to waste. A relatively small volume of water is needed (0.2 to 0.25 percent of the water filtered).

For efficient operation, it is necessary to pretreat a highly turbid or colored water by means of coagulation and settling but raw water with a turbidity up to 60 to 80 mg/L can be filtered without pretreatment. In any case, prechlorination is considered a necessary adjunct to filtration. The diatomite filter must be properly operated by trained personnel in order to obtain dependable results.

A major weakness in the diatomite filter is that failure to build up the filtering mat will make the filter entirely ineffective and give a false sense of security. During filtration, the head loss through the filter may increase to 40 or 50 psi, more or less depending on design, before backwashing, thereby requiring a pump and motor with a wide range of head characteristics to obtain the design rate of flow. The cost of pumping water against the higher head is therefore increased. Diatomite filters cannot be used where pump operation is intermittent, as with a pressure tank installation, for the filter cake will slough off unless sufficient continuous recirculation is provided. A reciprocating pump should not be used.

Coagulation and Settling

Plain sedimentation, as in a reservoir, lake or basin, results in the settling out of suspended solids, the removal of color due to the action of sunlight, and the death of bacteria principally because of the unfavorable temperature, lack of suitable food and the sterilizing effect of sunlight. Plain sedimentation, however, has some disadvantages and is not generally economical unless a natural reservoir or basin is available. Presettling reservoirs ahead of coagulation basins are sometimes used to help remove heavy turbidity and to aid in reducing the concentration of polluting substances. For example, prolonged sedimentation appears to be effective in removing certain detergents and other complex compounds that would normally pass through a conventional plant.

Coagulation and Flocculation

The addition to water of a coagulant such as alum results in the for-

mation of a flocculant mass, or floc, which enmeshes microorganisms and suspended particles, removing and attracting these materials, as well as colloidal matter. The common coagulants are alum, sodium aluminate, copperas, ferrous and ferric sulfate and ferric chloride. Their use and the chemical reactions employed are described in "Operation of Water Treatment Plants" (29) and in "Water and Sewage Chemistry and Chemicals." (30) Mixing of the coagulant and other chemicals with the water to be treated is usually done in two steps, rapid and slow mixing. Rapid mix, a violent agitation for 1 or 2 minutes at average flow, may be accomplished by a mechanical agitator, pump impeller, baffles, hydraulic jump or other means. Mechanical mixers are available to treat flow as low as 25 to 30 gpm. Slow mix is accomplished by means of over-and-under or round-the-end baffles or mechanical paddles for 20 to 30 minutes to promote formation of a floc. A loss of head of 0.5 ft. to 3 ft. dependent on design velocity, can be expected in the baffled mixing basin. The coagulated water then flows to the settling or sedimentation basin which should provide a retention period of 4 to 6 hours. The settled sludge should be removed continuously or on a timed schedule. Rectangular tanks usually have a length two to five times the width and a water depth of 6 to 15 ft. Around 80 percent of the turbidity, color and bacteria are removed by this treatment. It is always recommended that there be at least two mixing tanks and settling basins to permit cleaning and repairs without interrupting completely the water treatment process, even though mechanical cleaning equipment is installed.

The Jeffrey Manufacturing Co. makes equipment for a vertical mixer or "Floctrol" and a rectangular settling basin with scraper and sludge collector for flows as low as 50,000 gpd using a 40-minute flocculation period, and a 2-hour settling period. Stuart Corporation makes walking beam flocculating equipment for flows as low as 250,000 gpd. Dorr-Oliver has equipment for flash mixing, flocculating and clarifying water. Walker Process Equipment Inc. makes equipment for mixers to handle flows as low as 36,000 gpd, but collecting equipment for settling basins is not applicable at plants less than about 100,000 gpd. Infilco makes the "Vorti-Floc" and collecting equipment for small to medium diameter settling tanks. Ralph B. Carter Co. makes equip-

ment for circular collectors to handle flows of 250,000 gpd and higher. Link-Belt, Process Engineers, American Well Works and Chain Belt Co. can furnish small clarifier equipment.

Suspended Solids Contact Clarifiers

During the past few years suspended solids contact clarifiers have been used in which chemical addition, mixing, coagulation and clarification take place in the same unit. The water to be treated is directed to or introduced at the bottom of the unit and flows upward through previously formed floc and accumulated sludge; the clarified water flows off the top. Excess sludge is collected and drawn off the bottom. A major advantage claimed for the suspended solids contact clarifier, where applicable, is reduction of the settling basin detention period from the conventional 4 to 6 hours to 2 hours or less.

The Graver solids-contact "Reactivator" is designed to carry out in 60 to 90 minutes the rapid mixing, slow mixing and sedimentation in one unit. The Walker Process "Clariflow" solids-contact unit provides a detention of $\frac{3}{4}$ to 2 hours, depending upon the temperature and quality of the water, and handles flows greater than 100,000 gpd. The Permutit "Precipitator" reduces the detention period to 1 hour or less. Units are available in very small sizes. Hungerford & Terry offer the "Coagulator" to coagulate and settle water flows as small as 50 gpm. The American Well Works has the "Flocsettler" to treat flows of 144,000 gpd and higher. The Cochrane "Solids-Contact Reactor" is as small as 11 ft. diameter and the Process Engineers high rate clarifier is made in 15-ft. diameters.

Chemical Feed Equipment

Equipment to feed chemicals is of the solution or dry-feed types. At small plants, in the 10 to 50 gpm range, solution feeders have been found to be reliable and accurate for adding the rather small quantities of chemicals normally required. However the preparation of solutions and computations are somewhat involved. Positive-feed solution feeders have been described under hypochlorination. Other types of solution feeders are made by Infico, Omega (B-I-F), Graver, General Filter and Cochrane.

The dry type chemical feeder is usually warranted in plants where the quantities of chemicals added to the raw water exceed approximately 10 pounds per hour. (31) Calculation of chemical dosage and weight

is facilitated by the use of dry feed equipment. Dry feeders are made by Permutit, Omega (B-I-F), Infico, Wallace & Tiernan, Cochrane, Jeffrey, Syntron, Leopold, Hardinge and others.

To overcome difficulty generally experienced in feeding very small amounts of lime solution, Culp (32) suggests a device for pumping continuously a large quantity of lime solution which is divided by means of a weir splitter box with most of the flow being returned to the solution chamber for repumping. This is shown in Fig. 8.

Special Treatment Problems

The procedure followed in small water systems to eliminate tastes and odors and to remove objectionable iron, manganese and other compounds are essentially the same as those employed in large water systems. Since most tastes and odors arise from the presence of algae, though some are due to industrial wastes, control will often be based on preventing algae growth. This is normally accomplished by using copper sulfate. To be most effective, the copper sulfate should be applied early, before any considerable growth of algae has developed. The use of ammonia in conjunction with chlorine will minimize development of some types of tastes and odors which are accentuated by chlorine alone. Chlorine dioxide and ozone have also been used.

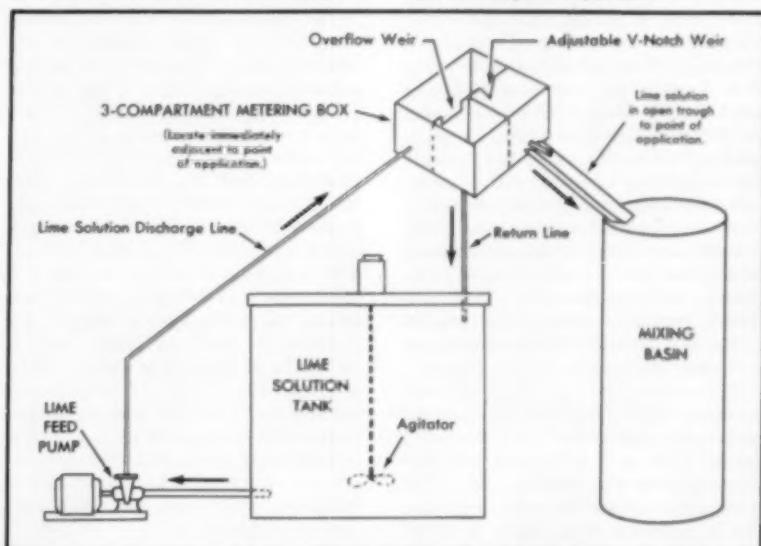
Iron and manganese can be removed by aeration, base exchange, filtration or addition of chemicals. The state in which these metals are

found will limit the methods that will be effective. For the small plant, the base exchange process will frequently be most convenient and effective.

Softening is also usually best accomplished in the small plant by base exchange, using either natural or artificial zeolites. Filters or contact beds for this purpose are available in a variety of sizes. Manufacturers of base exchange equipment include American Water Softener Co., Belco, Cochrane, Dorr-Oliver, Elgin Softener Corp., General Filter Co., Graver Water Conditioning, Infico and Permutit.

Hydrogen sulfide is partially removed by aeration in the open atmosphere and by pressure tank aeration. This must be supplemented by other processes for complete removal, such as chlorination, settling and filtration. Carbon dioxide is added by aeration, tending to raise the pH above the 4.5 optimum. Chlorination alone effects complete removal but may be expensive for high concentrations. A synthetic resin is made by Rohm and Haas Co. which can remove H.S.

The normal processes of treatment to remove or to control tastes and odors, to remove iron and manganese, to soften water and to prevent scale or corrosion are described in most standard texts in water supply and are also treated simply in "Operation of Water Treatment Plants" (29). Additional data will be found in "Water and Sewage Chemistry and Chemicals" (30). These texts will be especially helpful for the small plant operator.



● FIGURE 8. Arrangement for feeding small quantities of lime solution to avoid line plugging troubles. Feed pump runs constantly; excess solution returns to tank.

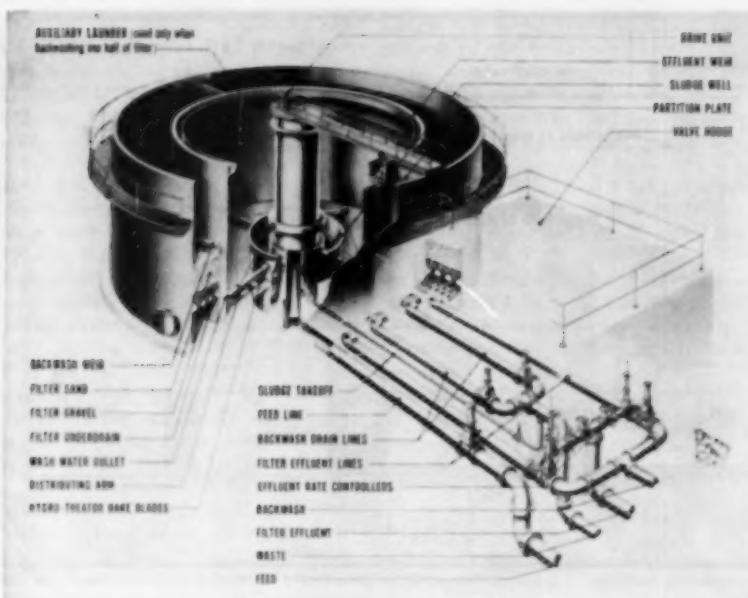


Photo courtesy Dorr-Oliver, Inc.

● FIGURE 9. Dorrco Perifilter System has 200,000 to 300,000 gpd capacity.

Pre-designed Plants

A limited number of complete pre-designed packaged gravity rapid sand filter plants, including chemical feeders, coagulation, sedimentation and filtration and water conditioning, if needed are available. Graver offers the "Graver Reactivator Package Water Treatment Plant," with capacities starting from 100,000 gpd. Permitit offers complete equipment for concrete filter shells and also steel and wood gravity filters for plants with capacities of 70,000 gpd and up. The smallest gravity rapid sand filter plant offered by Hardinge has a capacity of 360,000 gpd. Dorr-Oliver offers the "Dorrco Perifilter System," a complete pre-treatment and filtration system contained in a single tank to treat water in the 200,000 gpd range and higher. Infico manufactures the "Accelapak," a complete package water treating plant in capacities ranging from 21,600 to 504,000 gpd. Process Engineers also furnishes package plants.

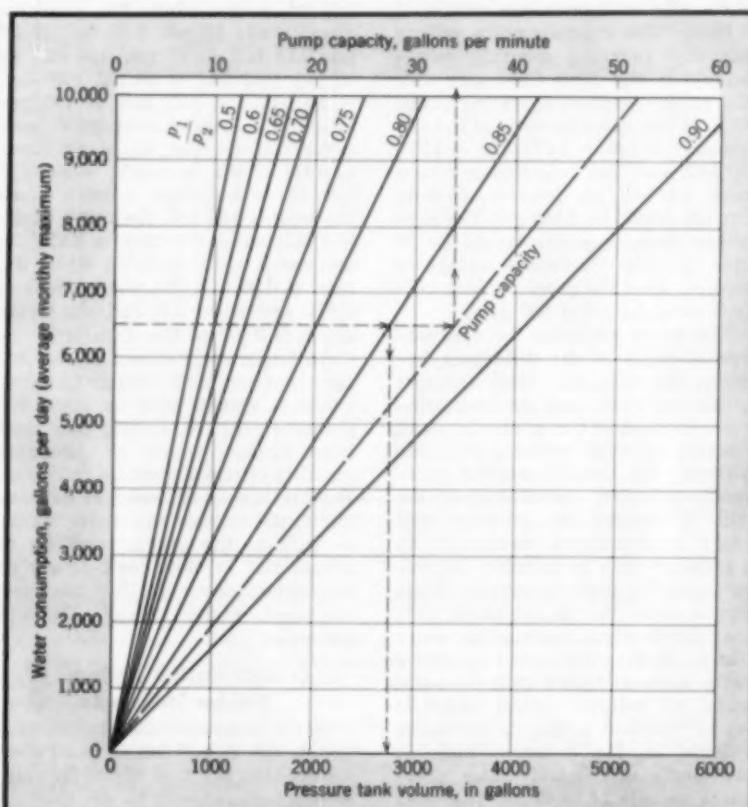
A prefabricated purification unit based on the "Erdlator" developed by the Corps of Engineers is now manufactured by Met-Pro, Inc. It involves aeration, mixing, coagulation and hypochlorination in a single unit, followed by a diatomite or sand and gravel filter. Pulverized limestone and ferric chloride are used as coagulant aids. Sludge is withdrawn into a separate concentrator. Units in capacities of 600 to 10,000 gph have been factory assembled.

Hydropneumatic Systems

Hydropneumatic, pneumatic or pressure tank water systems are

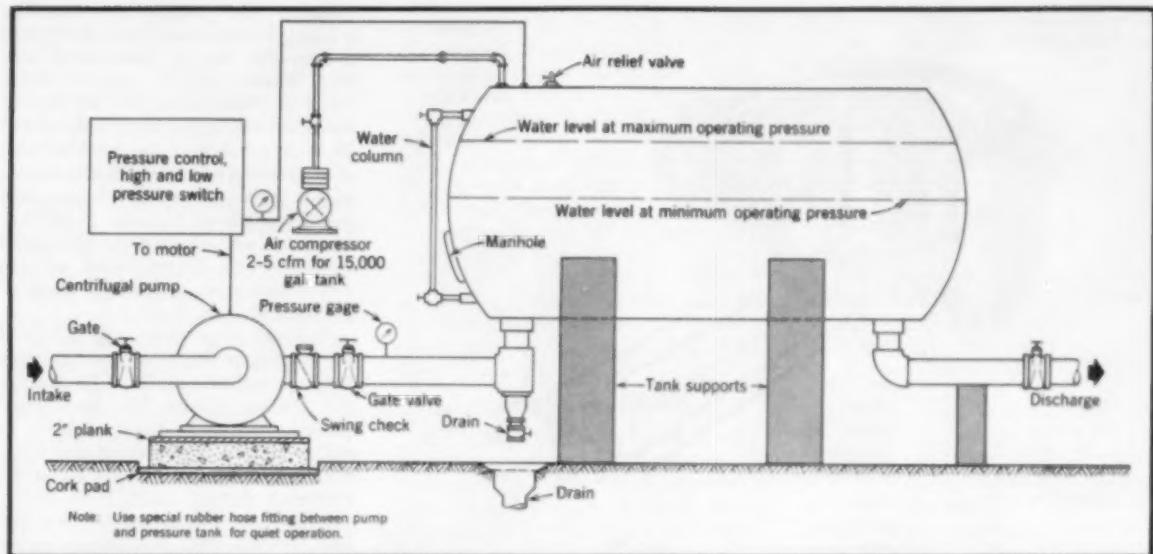
suitable for small communities, housing developments, private homes and estates, camps, restaurants, motels, hotels, resorts, country clubs, factories, institutions and as booster installations. In general, only about 10 to 20 percent of the total volume of a pressure tank is actually available. Hydropneumatic tanks are usually made of 3/16-in. or thicker steel and are available in capacities up to 10 or 20 thousand gallons. Small tanks are sometimes made of galvanized iron.

Various rules of thumb are used to determine the size of a pressure tank. A volume of 10 to 35 gallons per person served has been suggested. Another basis, which is shown in Fig. 10, assumes the pressure tank being just empty when the pressure gauge reads zero, hence the tank pressure and volume follow Boyle's law. The "pump capacity" given on the curve is equal to 125 percent of the maximum hourly demand rate (taken as 6 times the average maximum monthly water consumption rate, with the average maximum monthly rate being 1½ times the average annual daily rate). The "pressure tank volume" on the graph is based on providing 15 min-



From *Environmental Sanitation* by Joseph A. Salvato, Jr., published by John Wiley & Sons, Inc., New York, 1968, and from J. A. Salvato, Jr., "The Design of Pressure Tanks for Small Water Systems," *J. Am. Water Wks. Assoc.*, (June 1949).

● FIGURE 10. Chart for determining pressure storage tank volume and pump size.



From *Environmental Sanitation* by Joseph A. Salvato, Jr., published by John Wiley & Sons, Inc., New York, 1958.

● FIGURE 11. Typical installation of a pressure storage tank and centrifugal pump for a small water supply.

utes storage at the maximum hourly demand, and P_1 is the minimum absolute operating pressure, or cut-in setting of the pressure switch (gauge pressure plus 14.7 psi), and P_2 is the maximum absolute pressure or cut-out setting of the pressure switch.

If the "Water consumption, gallons per day (average monthly maximum)" in Fig. 10 is 6,500 gal, with the gauge pressure operating range 40 to 50 psi, then the ratio of P_1 to P_2 , absolute is $(40 + 14.7)/(50 + 14.7) = 0.85$, and the indicated pressure tank volume to provide 15-min. storage would be 2,700 gal. The suggested pump capacity would be 34 gpm. If only 5 minutes storage is desired, then the pressure tank volume need be about 900 gal.

The water available for distribution is equal to the difference between the dynamic head (friction plus static head) and the tank pressure. Because of the relatively small quantity of water actually available between the usual operating pressures, a higher initial (when the tank is empty) air pressure and range is sometimes maintained in a pressure tank to increase the water available under pressure. When this is done, the escape of air into the distribution system is more likely. Most very small pressure tanks come equipped with an automatic air volume control which is set to maintain a definite air-water volume in the pressure tank at previously established water pressures, usually 24 to 40 psi. This does not provide for flexibility of operation, but has application in very small installations. An installation

which does provide for flexibility of operation, including an air compressor, is shown in Fig. 11.

Starting with the pressure tank just empty when the pressure gauge reads zero, the tank will be 0.40 full of water when the pressure gauge reads 10 psi, 0.58 full at 20 psi, 0.73 full at 40 psi, 0.80 full at 60 psi, 0.85 full at 80 psi, 0.86 full at 90 psi, and 0.87 full at 100 psi. When a horizontal cylindrical tank is 0.40 full of water, the water depth is 0.421 of the diameter; when 0.73 full, the water depth is 0.685; when the tank is 0.80 full, the water depth is 0.745; when the tank is 0.85 full, the water depth is 0.795; when the tank is 0.90 full, the water depth is 0.845; and when 0.95 full, the water depth is 0.905 of the diameter.

An important element in the design of a pumping station and distribution system, with or without a pressure tank, is finding the total head against which an adequate quantity of water must be delivered. For the supply of water to be adequate, the storage and water mains, as well as the pump, must be of proper size to meet peak hourly or momentary demands. This has been discussed under "Peak Demand Estimates."

Distribution System Design Standards

So far as possible distribution system design should follow usual good waterworks practice. Mains for residential areas should be designed on the basis of at least 250 gpcd, plus a residual pressure of not less than 30 psi nor more than 125 psi, using

the Hazen and Williams coefficient $C = 100$. In small communities and in subdivisions, the peak hourly demand may reach 500 or 1000 percent of the average daily consumption, as explained in the section "Peak Demand Estimates." Fire protection requirements plus lawn sprinkling and domestic demand will govern. In cities with a population greater than 100,000 the peak hourly demand is greater than the fire demand plus the average domestic demand, and is about equal in cities of 25,000 population. But in smaller communities, the fire demand will greatly exceed the peak domestic hourly demand (33).

Air release and vacuum valves are provided where necessary at all high points on the transmission lines, and blowoffs at low drain points. These valves must not discharge to below-ground pits unless provided with a gravity drain to the surface above flood level. So far as is possible in small systems, dead ends should be eliminated or a blowoff provided, and mains should be tied together at least every 600 ft. Lines less than 4 in. in diameter should generally not be considered, except for the smallest system, unless they parallel secondary mains on other streets. Although the design should aim to provide a pressure of 30 psi in the distribution system during peak flow periods, 20 psi minimum may be acceptable. A minimum pressure of 60 to 75 psi is desired in business districts, although 50 psi may be adequate in small villages with 1 and 2-story buildings.

Valves are spaced between 500 and 750 ft. apart and at street intersections. A valve book, at least in triplicate, should show permanent ties for all valves, number of turns to open completely, left or right hand turn to open, manufacturer and dates valves operated. A gate valve should be provided between each hydrant and street main.

Water lines should be laid below frost, about 6 ft. above and 10 ft. in a horizontal direction from any nearby sewers. Where sewers cross water mains, sewers for a distance of 10 ft. on each side should be constructed of pressure pipe 18 in. and laid lower and with watertight joints. If water and sewer lines must be laid in the same trench, the water main should be offset on an undisturbed earth shelf, with the bottom at least 12 in. above the top of the sewer line. Both lines should be cast iron with mechanical joints or equal construction. It must be recognized that this type of construction is more expensive and requires careful supervision during construction. Mains buried 5 ft. are normally protected against freezing and external loads.

The selection of pipe sizes is determined by the required flow of water that will not produce excessive friction loss. Transmission mains for small water systems more than 3 to 4 miles long should not be less than 10 to 12 in. in diameter. Design velocity is kept under 5 fps and head loss under 3 ft. per 1000. If the water system for a small community is designed for fire flows, then the required flow for domestic use will not cause significant head loss. On the other hand, where a water system is designed for domestic supply only, the distribution system pipe sizes selected should not cause excessive loss of head. Velocities may be 1½ to 5½ fps. In any case, a special allowance is usually necessary to meet water demands for fire, industrial, and other abnormal purposes.

Design velocities as high as 10 to 15 fps are not unusual, particularly in short runs of pipe. The design of water distribution systems can become very involved and is best handled by a competent sanitary engineer. Where a water system is carefully laid out, without dead ends, so as to divide the flow through several pipes, the head loss is greatly reduced. The friction loss in a pipe connected at both ends is about one-quarter the friction loss in the same pipe with a dead end. And the friction loss in a pipe from which water is being drawn off

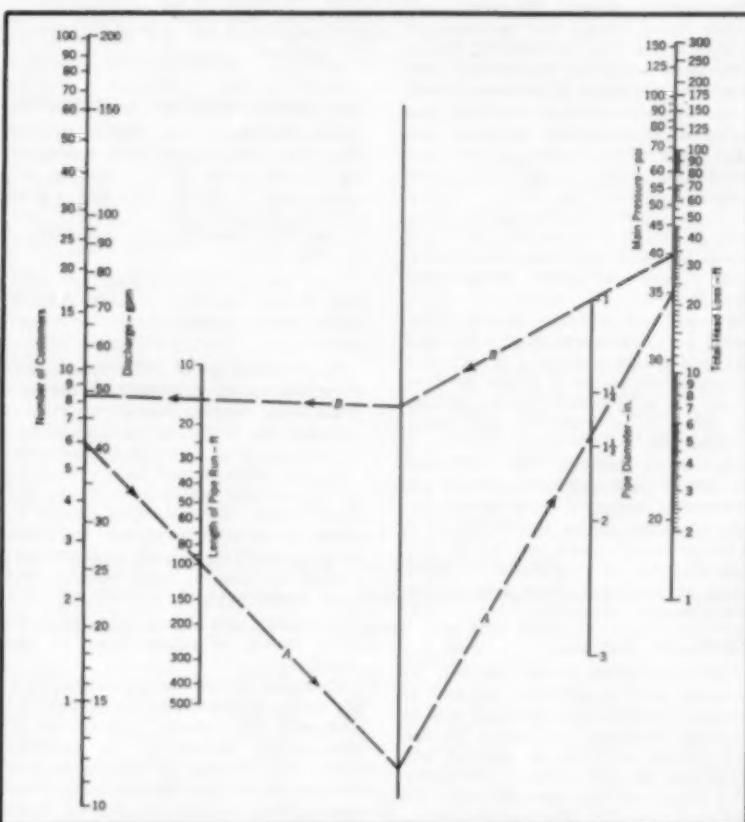
uniformly along its length is about one-third the total head loss.

In some communities, where no fire protection is provided, small diameter pipe may be used. In such cases, a 2-in. line should be no more than 300 ft. long; a 3-in. line no more than 600 ft.; and a 4-in. line no more than 1200 ft.; and a 6-in. line no more than 2400 ft. If lines are connected at both ends, 2-in. or 3-in. lines should be no longer than 600 ft., and 4-in. lines not more than 2000 ft. A useful "Pipe Size Determination Chart" for small lines is shown in Fig. 12.

Hudson (34) suggests as a rule-of-thumb that a 6-in. main can be

extended only 500 ft. if the average amount of water of 1,000 gpm is to be supplied for fire protection, or about 2,000 ft. if the minimum amount of 500 gpm is to be supplied. An 8-in. line will carry 2.1 times as much water as a 6-in. line for the same loss of head and costs only about \$1.00 more per ft. to buy and install.

The minimum pipe sizes and rule-of-thumb guides mentioned above are not meant to substitute for distribution system analysis but are intended for checking or rough approximation. Use of the equivalent pipe method, Hardy Cross method, or one of its modifications should be



From: William C. Weiman, "Service Rules and Standards for California Water Utilities," *J. Am. Water Wks. Assoc.*, (Jan. 1958).

● FIGURE 12. Pipe size determination chart.

Nomograph assumes a minimum service pressure of 25 psi for metered customers using dead-end pipelines. For flat rate service, divide the number of customers by two; for circulating pipelines, the number of customers may be doubled on the 2-in. and 3-in. sizes. On the left scale, the number of customers N is related to the discharge Q by the formula $Q = 15N^{0.381}$. On the right scale, the total head loss is the actual head loss in the pipe.

Example A: Given number of customers (6), length of line (100 ft), and main pressure (35 psi), find pipe size. Connect points on two left scales and extend line to intersect with centerline of chart. Connect intersection with point on right scale. Read answer on pipe diameter scale (between 1½ and 2 in.; use 1½ in.).

Example B: Given main pressure (40 psi), pipe size (1 in.), and length of line (15 ft), find number of customers. Connect points on two right scales and extend line to centerline. Connecting the intersection with point on left scale, read answer on customer scale (between 8 and 9; use 8).

adequate for the small distribution system.

As stated earlier under "Fire Protection, Monetary Savings," a water system which provides adequate fire protection is to be highly recommended where possible. The fire insurance savings should at the very least be compared with the additional cost of increased pipe size, plant capacity and water storage to provide fire protection. Certainly if the cost of 8-in. pipe is only

\$1.00 more per ft. than 6-in. pipe, as reported by Hudson, the argument for the larger diameter pipe where needed is very persuasive. In any case, only pipe and fittings that have a permanent type lining or inner surface should be used.

The New York Fire Insurance Rating Organization Engineering Department recommends the following design standards for new construction and for long range improvement of existing systems:

Recommended WATER SYSTEM DESIGN STANDARDS

MINIMUM PIPE SIZE.

Residential areas: Six-inch and smaller mains should not be installed as dead ends. The gridiron of minor distributors supplying residential districts should consist of mains at least 6-inch in size arranged so that the lengths on the long sides of blocks between intersecting mains do not exceed 600 feet. Where longer lengths are necessary, 8-inch or larger mains should be used. (Where initial pressures are high, a satisfactory gridiron may be obtained with longer lengths of 6-inch pipe between intersecting mains.)

In new construction 8-inch pipe should be used where dead ends and poor gridironing are likely to exist for a considerable period or where the layout of the streets and the topography are not well adapted to the above arrangement.

High value districts: The minimum size should be 8-inch where there are intersecting mains in each street; 12-inch or larger mains should be used on the principal streets and for all long lines that are not connected to other mains at intervals close enough for proper mutual support.

SPACING OF VALVES.

The distribution system should be equipped with a sufficient number of valves so located that no single case of accident, breakage, or repair to the pipe system, exclusive of arteries, will necessitate the shut-down of an artery or a length of pipe greater than 500 feet in high-value districts or greater than 800 feet in other sections.

HYDRANT DISTRIBUTION.

Distribution of hydrants should be based upon the required fire flow, the average area served not to exceed that given in the following table.

Fire Flow Required, GPM	Avg. Area per Hydrant, square feet
1,000 or less	120,000
2,000	110,000
3,000	100,000
4,000	90,000
5,000	85,000
6,000	80,000

Maximum spacing: Near service limits and in sparsely settled areas sufficient hydrants should be installed to provide at least one within 600 feet of all buildings.

SIZE AND INSTALLATION OF HYDRANTS.

Hydrants should be able to deliver 600 gallons per minute with a friction loss of not more than 5 pounds per square inch in the hydrant and a total loss of not more than 5 pounds per square inch between the street main and the outlet;

They should have at least two 2½-inch outlets, and also a large pumper outlet where pumper service is necessary;

They should be of such design that when the barrel is broken off the hydrant will remain closed;

Connection to the street main should be not less than 6 inches in diameter;

A gate valve should be provided on all connections between hydrants and street mains; first attention should be given to providing valves in street main connections on all hydrants installed on supply lines, arteries and main feeders;

Operating nuts and direction of operation should be standard on all hydrants;

Hydrants should be set so that they are easily accessible to fire department pumpers; they should not be set in depressions, cutouts or on embankments high above the street; pumper outlets should face directly toward the street; with respect to nearby trees, poles and fences, there should be adequate clearance for connection of hose lines. Hydrants should be painted a distinguishing color so that they can be quickly spotted at night.

Table 9, "Required Fire Flows, Average City and Residential Districts" summarizes flow rates, the total fire flows, and municipal flows for population groups of 100 to 10,000 for the duration of the indicated fire. The designing engineer is urged to submit his water system plans to the local rating organization of the National Board of Fire Underwriters for review before final

plans and specifications are let out for bids. One must be alert to assure that fire protection programs do not include pumping from polluted sources into public or private water supply mains through hydrant or blowoff connections. Nor should bypasses be constructed around filter plants or provision made for "emergency" raw-water connections to supply water in case of fire.

Cross-Connection Control

A discussion of water system design would not be complete without reference to cross-connection control. It is fundamental that there should be no cross connection between safe (potable) and unsafe (nonpotable) water supplies. It is the responsibility of the designing engineer, the water works official and the health department to prevent possibilities of pollution of public and private water supplies. Because of the practical difficulties of obtaining and maintaining complete separation of potable and non-potable water supplies, particularly within a property, the designing engineer would do well to discuss potential problems with state and local health department sanitary engineers. An excellent summary of the present status of cross-connection control is given in a recent Joint Committee Report (35) of the American Water Works Association and the Conference of State Sanitary Engineers.

Pumping and Storage

The distribution of water involves the construction of a pumping station, unless a satisfactory source of water is available at an elevation to provide a gravity supply. The size of pump selected is based upon whether hydropneumatic storage (steel pressure tank), ground level, or elevated storage is to be used, the available storage provided, the yield of the water source, the water usage and the demand. An estimate of the probable quantity of water needed per day can be obtained by referring to Tables 1 and 2 and Fig. 1. Actual meter readings should be used, if available, with consideration being given to future plans, periods of low or no usage, and maximum and peak water demands. Average water consumption figures must be carefully interpreted and considered with required fire flows. In deciding upon the type of storage, one should know the dependability of power, the availability of standby power and pumping equipment, the promptness with which repairs can be made and de-

fective equipment replaced. Where possible, elevated or gravity storage providing two, three, or more days storage is to be preferred, as this usually makes for a more dependable water system. If the water system is to provide also fire protection, then elevated storage is practically essential, unless ground-level storage with adequate pumps are available. Storage tanks or basins should be covered and protected from flooding, willful or accidental pollution, and the entrance of animals and birds.

The capacity of the pump required for a domestic water system with elevated storage is determined by the daily water consumption and volume of the storage tank. Where the topography is suitable, the storage tank can be located on high ground, although the hydraulic gradient necessary to meet the highest water demand may actually govern. The pump should be of such capacity as to deliver the average daily water demand to the storage tank in 6 to 12 hours. In very small installations the pump chosen may have a capacity to pump in two hours all the water used in one day. This may be desirable where the size of the centrifugal pump is increased to 60 gallons per minute or more and the size electric motor to 5 to 10 horsepower or more since the efficiencies of these units then approach a maximum. This may re-

quire larger transmission lines, but generally other considerations will result in selecting a larger line. Due consideration must also be given to the increased electrical demand and the effects this has. A careful engineering analysis should be made.

Pump Pits

It is sometimes suggested that pumps be placed in pits or on the top of a well casing which has been terminated below ground level. Anyone who has had to go down into a pump pit to service a motor and switches, or take daily main meter readings, and who has tried to overcome the problem of condensation and drainage of surface water or superficial ground water, or who has had the problem of cleaning out and disinfecting a flooded well pit soon concludes that a pump or well pit is something to be avoided. A possible exception is a readily accessible pit which is above flood level and which can be drained to the ground surface by gravity flow. Turbine and submersible pumps lend themselves to above ground or ground level installations. Where housing is necessary, the pumps, thermostatically controlled heaters, control panels, valves and meters can be located in an above-ground structure. Excavation, reinforced concrete roof, a sump pump, and ventilating fan, which add to

the cost of pump pits, can be eliminated with above ground or ground level structures. In addition, as previously indicated, maintenance and operation are simplified. Fig. 13 shows a simple above ground installation.

Many types of pumps are available. These will be of the same kinds and are generally selected on the same bases as pumps for larger water supplies. Serious consideration should be given to duplication of pumping units and to the provision of standby power for at least a portion of the supply.

Fluoridation

The addition of fluorides to drinking water is relatively simple and easily controlled. Water containing 0.6 to 1.2 mg/L natural or artificial fluoride is beneficial to children during the period they are developing permanent teeth.

Equipment to feed fluoride is of the same type as is used to feed sodium or calcium hypochlorite, lime, alum, activated carbon and other chemicals. Dry or solution feeders are available; but for more accurate control, solution feeders are preferred at small water plants. Plans of proposed installations and equipment should be approved by the health department. Equipment purchased should include an approved type test kit to measure the concentration of fluoride ion added

Table 9—Required Fire Flows, Average City and Residential Districts*

Population	Flow Rate	Flow Rate	Duration	Required Fire Flows for Average City			Required Fire Flows for Residential Districts			
				gpm	mgd	hours	Fire Flow gals.	Municipal Flow gal. (b)	Total Flow gal. (c)	
100	250(a)	0.36	4	60,000	3,750	63,750	2(a)	30,000	1,250	31,250
250	500	0.72	4	120,000	9,375	129,375	2(a)	60,000	3,125	63,125
500	750	1.08	4	180,000	18,750	198,750	2(a)	90,000	6,250	96,250
1,000	1,000	1.44	4	240,000	37,500	277,500	2(a)	120,000	12,500	132,500
1,500	1,250	1.80	5	375,000	70,200	445,200	2½(a)	187,500	23,400	210,900
2,000	1,500	2.16	6	540,000	112,500	652,500	3(a)	270,000	37,500	307,500
3,000	1,750	2.52	7	735,000	196,875	931,875	3½(a)	367,500	65,500	333,000
4,000	2,000	2.88	8	960,000	300,000	1,260,000	4	480,000	100,000	580,000
5,000	2,250	3.24	9	1,215,000	422,500	1,637,500	4½	607,500	141,000	748,500
6,000	2,500	3.60	10	1,500,000	562,500	2,062,500	5	750,000	187,500	937,500
10,000	3,000	4.32	10	1,800,000	937,500	2,737,500	5	900,000	312,000	1,212,000

Adopted from Standard Schedule for Grading Cities and Towns of the United States with reference to Their Fire Defenses and Physical Conditions, National Board of Fire Underwriters, New York, 1956.

*For residential districts, the required fire flow shall be determined on the basis of structural conditions and congestion of buildings. In districts with about 1/3 the lots in a block built upon having buildings of small area and of low height, at least 300 gpm is required; if the buildings are of larger area or higher, up to 1,000 gpm is required; where districts are more closely built or the buildings consist of high value residences, apartments, tenements, dormitories, or similar structures, 1,500 to 3,000 gpm is required, and in densely built districts with 3-story and higher buildings, up to 6,000 gpm is required.

(a) In certain states a minimum flow of 500 gpm at 20 psi for at least 4 hours duration is required.

(b) Water usage for fire flow purposes is the maximum day flow (1.5 times the average daily consumption). In this example it is assumed that flow for the average city to be at the rate of 225 gpcd and flow for residential districts to be at the rate of 150 gpcd, both for the hours duration of the fire flow.

(c) The total flow may be provided by storage alone or by system capacity plus storage.



FIGURE 13. Simple above-ground well pumping station with submersible pump.

to the water and to control the operation of the fluoridator.

Fluoridators can be adjusted manually to feed fluoride at a constant rate, where the amount of water to be treated does not change, or mechanically to feed fluoride proportional to the flow of water. The point of treatment is usually determined by the availability of a location which will permit uniform mixing, convenience in application, and testing for the fluoride ion for control purposes.

In 1956 the Public Health Service introduced a fluorspar dissolver using CaF_2 , and a saturated fluoride solution of strengths proportional to the concentration of alum solution. By adding an 11 percent alum solution to the dissolver containing finely ground fluorspar it is possible to add 1 mg/L fluoride to the water to be treated together with 10 mg/L alum, using a solution feeder.

Solution feeders for adding fluorides can be obtained from the manufacturers of hypochlorinators. A sodium fluoride dissolver unit is available from B-I-F Industries. Fluoride dry feeders are similar to other dry feeders.

Powdered fluoride compounds produce a dust when handled which can be harmful. Dust collection equipment at the feeder where the powder is added, and dust masks approved by the Bureau of Mines, including rubber gloves, will greatly minimize the hazard. Provision should be made to exclude unauthorized persons from the room where fluoride compounds are stored or handled.

Responsibilities of Designer

The importance of studying the community and designing for the conditions likely to prevail is re-emphasized. The designing engineer will assist himself and the health department sanitary engineer if he will emphasize to the local officials and water companies the great re-

sponsibility carried by the water plant operator to provide an uninterrupted supply of water and continuity of information to permit efficient maintenance and operation of the water system. This and his devotion to duty should be recognized by assuring him good working conditions and a salary commensurate with his ability. The equipment manufacturer and the designing engineer should explain realistically the value and limitations of automation and the skills needed to keep such equipment in proper operating order. It should also be emphasized again and again, particularly in connection with small water plants, that the best design, plans and specifications are not much better than the inspection and supervision during construction.

Operation Control

The reader is referred to "Operation of Water Treatment Plants" (29) for more complete coverage of this phase. The extent of water plant operation control is determined by the complexity of the system, source of water (surface or underground), degree of pollution of the water source, and treatment required. Records should be kept and reports made to responsible officials and health authorities having jurisdiction. Reports on a well water supply that does not require treatment should include the static water level and pumping level weekly; the gallons of water pumped each day; power consumption; storage tank water level; monthly or quarterly bacteriological examination of a water sample including chloride and nitrate determinations; annual complete chemical examination; and number of new service connections, repairs and complaints. A treated water would call for more complete daily records usually on forms provided or approved by the health department.

The plans and specifications should provide for the equipment and facilities to accomplish the above. This would include provision for water level readings in a well and record of water pressures and flows. A rapid sand filter plant should include apparatus to make jar tests, pH, turbidity, residual chlorine, carbon dioxide, nitrogens, hardness, alkalinity, iron, and the bacterial, microscopic and physical tests needed to produce a water of satisfactory sanitary quality, the extent and types of tests dependent upon the source of raw water and controls. Surface water supplies should include provision for rainfall, stream and dam overflow measurements.

In most states the health department is in a position to make monthly or quarterly bacteriological examinations and annual complete chemical analyses in connection with their conventional supervision. Assistance with special problems is also generally available. Tests for the daily operational control of a rapid sand water treatment plant purifying a seriously polluted water should be made at the water plant daily or more often by a fulltime person trained in making and applying the required tests. Fig. 14 shows a sketch of a small laboratory capable of handling 10 bacteriological samples a day or 100 per month, several microscopic and chemical samples per day, and other routine tests for operating control. The laboratory would require gas, water, vacuum, and 3-wire 2-phase 220-volt electric service for the still (1 gallon per hour with 10 gallon storage capacity); also a hot air sterilizer, autoclave and possibly a kiln. A fairly constant temperature (69°F to 80°F) and air conditioning are practical necessities. Water sampling lines should be run to the laboratory where possible. Work shelves and table tops 30 in. above the floor are convenient to perform biological work sitting down; work counters for chemical work can be 36 in. high. A list of laboratory equipment to perform the required tests for plant control can be obtained from most health departments.

Laboratory furniture is available from Precision Scientific, Metalab, Sheldon, Hamilton and Keweenaw. Equipment may be obtained from Phipps & Bird, Aloe, Central, Chicago, Eberbach, Eimer and Amend, Fisher, Harshaw, Precision, Sargent, Will and many others.

Anyone employing a consulting engineer, in addition to the usual

professional services, should expect to receive complete and accurate drawings of the water works as installed. This should include, if applicable, complete watershed maps as explained under "Surface Sources of Water," flow diagrams, equipment details, well logs, and distribution system maps with valve tie-ins and record books. Where a treatment plant or other equipment is involved, the plant is not turned over until all equipment has been tested and operating personnel are thoroughly trained.

The water plant area or pumping station should be simply landscaped and equipped with outside flood lighting. A basin with running water, a hose bib outlet, toilet facilities, clothes locker, and adequate storage facilities are minimum facilities.

Acknowledgements

A large amount of material has been reviewed in the compilation of this study. Thanks are due equipment manufacturers, manufacturers' representatives, and state and county sanitary engineers for making available literature, cuts, bulletins and administrative guides.

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● FIGURE 14. Water laboratory equipped for chemical and bacteriological tests.

KEY TO LABORATORY DIAGRAM: (1) Refrigerator; (2) Small sink; (3) Chemical work area, 36" high; (4) Autoclave; (5) Hot air sterilizer; (6) Distilling equipment; (7) Deep sink and drain; (8) Desk; (9) Bacteriological area, 30" high; (10) Incubator; (11) Wall storage; (12) Work table area; (13) Storage under counter; (14) Acid storage over sink; (15) Shower; (16) Lavatory.



● MUNICIPAL REFUSE PRACTICES in OKLAHOMA

LeROY K. RACHELS

Entomologist,

Division of Sanitary Engineering,
Oklahoma State Department of Health

WHAT percentage of Oklahoma communities have a regular system of refuse handling? What are the storage requirements? What are the collection and disposal practices? What are the methods of finance? Cost of operation? These and other similar questions have arisen from time to time, with no clear cut information available. As a result, the Vector Control Section, Division of Sanitary Engineering, sent questionnaires on "Municipal Refuse Collector and Disposal" to 292 cities and towns of Oklahoma with population figures of 500 or more according to the 1950 census. The information received from the questionnaires reflected conditions as of 1957-58.

Of the questionnaires sent out, 141 or 48 percent were returned. The 141 municipalities answering indicated that 62.4 percent (88) had a regular system of refuse handling while 37.6 percent (53) had none. To analyze the practices among the 88 cities with regular systems, the municipalities were placed in the following population brackets: 500 to 5,000—52 or 59.1 percent; 5,000 to 10,000—13 or 14.8 percent; 10,000 to 30,000—17 or 19.3 percent; 30,000 to 60,000—4 or 4.6 percent; over 60,000—2 or 2.3 percent.

Storage

The questionnaires indicate that the majority of cities and towns in Oklahoma do not require specific separation of garbage from other refuse. Less than 50 percent require special type and size containers for refuse storage, particularly in residential areas. However, as the cities increase in size, the reports indicate that special type and size containers are usually for storage. The requirements on separation of garbage from other refuse and special containers are as follows: In the 500 to 5,000 population group comprising 52

cities, 18 require separation of garbage and 34 do not; 19 require special containers and 33 do not. In the 5,000 to 10,000 group of 13 cities, only 2 require separation and 5 specify separate containers. In the population area above 10,000, 23 cities reported, 5 requiring separation (all under 30,000 population) and 18 special containers.

Collection

Of those municipalities having a regular system of refuse handling 67 or 76.1 percent had municipal collection of refuse; 23.9 percent or 21 used contract collection or other service. More than 86 percent of these reported municipal collection in both business and residential areas. In a few instances the business area is handled by municipal collection and the residential area, by contract, or vice versa. The report is as follows:

Frequency of Collection: Of those municipalities indicating municipal refuse collection, more than 79 percent (53) reported daily collection in the business area and more than 80 percent (54) reported once or twice a week collection in the residential area; 32 reported collection twice a week and 22 collection once a week.

In business areas, 53 cities provided daily collection; 5 collected 2 or 3 times a week; the remaining 9 cities reported variations ranging from once a week to "when needed." In residential areas, 32 cities provide twice a week collection; with 22 have once a week collection; with the other 13 at longer or irregular intervals.

Rates: In general, the monthly service rates are set by ordinance. Those for residential areas vary from no charge to \$2 for each residence. The tabulation of the monthly service rates shows that 50 cents to \$1 per month is the most popular figure, being used by 40 of the 67 cities; 11 make no charge.

No definite information was given on the questionnaires by which service rates on business collections could be tabulated. The following methods for establishing rates were reported by 61 municipalities: On the basis of volume collected, 17 cities or 27.9 percent; time required for collections, four cities or 6.6 percent; combination of volume collected and time required for collection, 3 communities; size of establishment, 19; and a flat rate, 12. Six communities make no charge.

Finance: Methods of financing refuse collection programs varied some, but more than 82 percent (55) cities of those communities having municipally operated collection used the municipal fee system. Other methods include: General tax fund, 8 cities; a combination of general tax fund and fee direct to contractor, one city; and from the water department, one city. Those communities having contract collection reported payments as follows: Municipal fees, six cities; general tax fund, one city; fee direct to contractor, 13 cities; and other means, one city.

Cost of Operation: Cost data that were sufficiently complete to estimate cost of collection and disposal per capita per month were reported by 50 communities. The lowest was

(Continued on page 246)

Table 1 — Data on Refuse Collection Frequency

Population	Twice Weekly Collection				Once Weekly Collection			
	No.	Low	High	Avg.	No.	Low	High	Avg.
500 to 5,000	7	302	1,143	631	10	143	1,286	705
5,000 to 10,000	5	857	1,284	1,085	6	952	1,714	1,301
10,000 to 30,000	12	681	1,857	1,237	1	1,429	1,429	1,429
30,000 to 60,000	6	1,347	2,142	1,663
Over 60,000	2	1,428	1,750	1,589

GRADE CAUSES PROBLEM IN BUILDING RESIDENTIAL STREETS

FRANK FORCE,
Borough Manager-Engineer,
Hellertown, Pennsylvania

WHEN building streets on 14 and 17 percent grades, you have to build them with modern equipment and have careful supervision.

Hellertown, Pa. completed in the fall of 1959 two blocks of residential streets. The block on Miller Street had a grade of 14.11 percent and the block on New Jersey Avenue was built at a grade of 16.97 percent. The property owners on these two streets asked the Borough Council to reconstruct them and it was Council's decision to proceed with the construction. The Borough ordinance on street construction calls for the property owners to pay for the curb and gutter and the Borough to pay for the street base and wearing surface.

The length of construction on Miller Street was 235 ft. and on New Jersey Avenue, 350 ft., including the Miller and New Jersey intersection. The concrete curb and gutter was installed by Francis Lancner, cement contractor of Bethlehem. Each year the Borough lets bids on curb, gutter, sidewalk and other concrete work and Lancner has been the successful bidder for this work for the last ten years.

The curb, which is 6-in. wide and 18-in. deep, with a 6-in. face, cost \$2.00 per lineal ft. installed, and the gutter, 30-in. wide and 6-in. deep, costs 75 cents per sq. ft. The streets were designed by Leonard M. Fraivillig Company, Consulting Engineers, Bethlehem. The consultant staked out the work and gave the line and grade in the field. The supervision of construction and inspection were under the Borough Engineer and the Superintendent of Streets.

Borough forces did most of the excavation to bring the streets to grade. They used a Model 303 Galion grader and an International and a GMC dump truck. An Allis-Chalmers HD-6 tractor-loader was rented from J. Fischel & Son, Hellertown,



● SLAG base 7 ins. deep was of No. 4 slag. It was spread by tailgating and was leveled with a Galion motor grader.



● START is made on applying C-1 cut-back. Distributor is a Hvass 1035-gal. capacity with Littleford circulating bar.



● COMPLETED job provides a street that is 30 ft. wide from face to face of the curbs, with a 30-inch concrete gutter. Steep gradients necessitated careful work.

at \$10.50 per hour to do the heavy ripping and loading. The Borough-owned International rubber-tired tractor and loader did the light loading.

The width of both streets is 30 ft. from face to face of curbs. With

30-inch gutters on either side, the width needed for base construction was 25 ft.

The slag base consisted of No. 4 slag bought from the Bethlehem Steel Company at \$1.60 a ton. About seven inches of slag were spread by



● PREPARATORY to applying the asphalt, a Galion motor grader owned by the Borough levels the slag base material.



● BITUMINOUS surface 2 inches thick was laid by Moto-Paver; three passes were required for the 25-ft. pavement.

tailgating from the two Borough trucks. Leveling was done by the Galion grader. Rolling was performed by a Huber-Warco 10-ton, 3-wheel roller rented from Lower Saucon Township at \$6.00 per hour. The slag was rolled to a compacted depth of about 6 in. Because of the steep grades, careful operation of the roller was necessary to prevent pushing of the slag instead of actual compaction.

A C-1 penetration cut-back was sprayed on the completed base at a rate of $1\frac{1}{2}$ gals. per sq. yd. The successful bidder for road oil used by the Borough has been the Interstate Asphalt Company of Quakertown, at a price of $16\frac{1}{2}$ cents per gal. This company buys the cut-back from the Texaco Asphalt Division. The material was spread in three passes on the 25-ft. strips by a 1035-gal. Hvaas distributor with a Littleford, full-circulating distributor bar.

A Moto-Paver was used to lay the 2-in. wearing surface. The material consisted of 1B stone mixed with a

C-1 cut-back at a rate of $\frac{3}{4}$ gal. per sq. yd. An additive was used in the mixture to take care of any moisture in the stone. The 1B stone was bought from the Bethlehem Steel Company at \$1.90 per ton and was hauled to the job by Borough trucks. The C-1 cut-back, supplied by the contractor, was mixed at 180°F . The Moto-Paver was rented from the Loder & Sharp Company of Quakertown at approximately \$25 per hour. The machine laid the surface in three widths, of which two were 8-ft. widths and one was 9-ft.

The rolling was done by a Huber-Warco roller rented from Lower Saucon Township. A very smooth riding surface was obtained which should provide an adequate surfacing for a number of years.

During 1960 the Borough has plans to do about 2500 ft. of new street construction. The same type base will be used on these projects and the same type curb and gutter will be utilized. A major sealing program is also planned to prevent further deterioration of the existing street

surfaces. There are only a few blocks of streets now in Hellertown that are not surfaced.

The Burgess of Hellertown is Warren C. Fritchman, the Chairman of the Street Committee is Harry Gregory and the Street Superintendent is Clarence Trauger. The photographs were taken with a Polaroid camera owned by the Hellertown Police Department.

• • •

State-wide Communications System for Highway Maintenance and Civil Defense

Alabama's State Highway Department has contracted with the General Electric Communication Products Department for 275 mobile radios as a means of speeding a road-building program involving a half billion dollars. In addition to the mobile units, to be used in cars and trucks, the system will include 48 General Electric base stations. These will be installed at the Highway Department's Montgomery Headquarters, seven division offices, and various highway camps and district offices throughout the state.

The mobile units will be used in vehicles operated by the key personnel responsible for more than one operation or road job. With radio, engineers and supervisors will be available within seconds, whereas in the past, it required numerous telephone calls and long delays to reach them.

It is anticipated that the state-wide radio hookup will be available also in the case of natural disaster or nuclear attack to augment existing communications facilities operated by law enforcement officers. Half the cost is to be paid by Federal Civil Defense matching funds.



● VERY SMOOTH riding surface was obtained by careful rolling following surfacing. Roller shown here, a 3-wheel Huber-Warco, was rented from nearby town.

SPRAY DISPOSAL of DOMESTIC WASTES

WILLIAM J. CHASE

Partner,

Hill & Ingman, Consulting Engineers,
Seattle, Washington

SPRAY irrigation of domestic sewage is relatively new in the United States; however, for the disposal of industrial wastes it has been used in this country for about ten years and has become quite common for many industries, but its use in disposing of domestic wastes is limited to the last two or three years and apparently almost exclusively to the Puget Sound region. Its use in this area for domestic waste disposal was prompted by the orders approximately three years ago from the Washington State Health Department and the Washington State Pollution Control Commission that additional disposal of sewage wastes, treated or untreated, into Lake Washington would not be permitted. Since it was neither possible nor desirable to stifle the growth of the area, it was necessary to arrive at an acceptable alternate means of handling domestic wastes in this area. Since septic tanks and tile-drainfield success had been minimal in the existing ground conditions, the disposal of treated sewage (primary treatment) by spray irrigation was the alternate means which seemed feasible and acceptable to the regulatory agencies.

During the last three years, spray field installations have been completed in the Puget Sound area to serve five developments, three installations being designed by Hill and Ingman. In addition, we are currently designing some similar installations for the U. S. Army Nike missile sites in this area. Such installations may prove desirable and economical for developers of towns in other areas not conveniently near a suitable body of receiving water.

A search of the literature regarding spray irrigation of wastes throughout the nation revealed that the vast majority of such installations were for cannery wastes, milk-plant wastes and pulp-mill effluent.



● FIRST-YEAR natural vegetation is abundant at the domestic waste spray field. Quick-coupling aluminum pipe and low pressure nozzles have been satisfactory.

The areas sprayed were usually planted in grass, in alfalfa or in a variety of natural weeds or grasses. Very frequently, they were in relatively flat areas or bottom land, probably owing to the proximity of the industrial plant to such land. Such irrigated areas usually presented a good appearance and sometimes even resulted in production of a profitable crop. However, there are little data on the latter. In nearly all installations the approach to the design of the irrigation system was almost entirely empirical.

Indications from various designs in the literature were that a great many factors affect spray field operation. These included the type of cover crop, the permeability of the surface and subsurface soils, the slope of the surface, the rate of application, the length of time the

waste was to be applied, the chemical characteristics of the waste, the chemical composition of the soils and, of course, the quantity of waste to be applied.

Soil and Vegetation Affect Design

While most spray fields have been in areas with grass or low-cover crops a notable exception is the Seabrook Farms installation in New Jersey. In that installation, untreated cannery waste is sprayed into a naturally wooded area. In 1950 between 500 and 600 in. of the waste was sprayed onto a 100-acre disposal area. The maximum application rate was 1,180 in. per year. This was significantly higher than was sprayed onto most grass areas. However, it appears fairly reasonable to expect a higher allowable applica-

tion rate in wooded areas than in cultivated or grass tracts. Hursh (1), in 1944, showed that the non-capillary storage capacity of an undisturbed forest area is almost three times that of a cleared and eroded area. Dreibelbis and Post (2), in 1941, noted these same results in a study of four watersheds, one predominantly woodland, one pasture land and two others cultivated. With an annual precipitation of 35.9 in. the woodland and pasture watersheds had 0.11 and 0.60 in. of runoff respectively while the cultivated watersheds gave 6.09 and 6.35 in. of runoff.

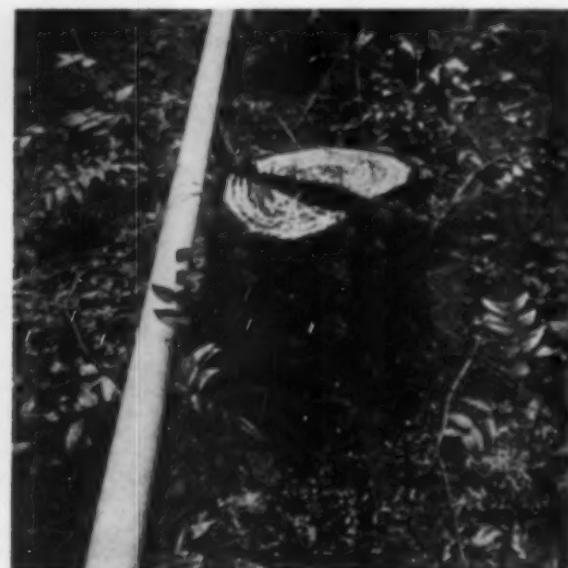
Thus, the permeability of the surface and of the subsurface soils is

spray field application rates are considerably in excess of that rate, ground-water movement and capillary storage must account for the major portion of the remainder. For adequate ground water movement to take place a reasonable hydraulic gradient must exist between the ground water in the spray field area and the ground water elevation in the surrounding area. Thus, if the areas are too flat, ponding might be expected before the hydraulic gradient would be adequate to result in sufficient ground water movement. This would account for some of the relatively low application rates required for satisfactory operation in some of the flatter low-

amounts of some clays. Clay soil, of course, does not absorb water as rapidly as loose loam or gravelly soil. Furthermore, some clay soil has the property of acting as a base-exchange material and will exchange the calcium normally present in the clay soil for the sodium present in the waste. If the clay soil becomes loaded with sodium it loses its ability to absorb water and becomes exceedingly hard. When this happens the growth of vegetation will become retarded. However, sodium cannot be considered alone but must be evaluated with other cations which may be present. The Department of Agriculture has developed the following formula for use in



● LUSH vegetation has developed at the two-year old St. Edwards Seminary site, but no significant problems occurred.



● ALGAL scum coated this stump, presenting a problem. It was probably due to excessive or too-frequent spraying of area.

a significant factor to evaluate and establish in the design of any spray field system. Fairly conventional means are available for evaluating these factors in relative terms but the exact means of correlating these relative terms to a scientific spray field layout is still a matter for mature judgment. Continued research is being accomplished in this field but experience in varied and comparable situations continues to be the main guide.

The slope of the ground surface is also a factor to consider in connection with the ground permeability since a major percentage of the water entering the ground from a spray field will leave the area as ground water. A good vegetation cover of the spray field area will evapotranspire an equivalent of 40 to 90 in. per year of moisture in the Puget Sound region. Since common

land installations where cannery wastes are sprayed. A problem in this category has been experienced in the operation of one of the initial spray fields to serve Lake Hills, a relatively large development east of Seattle. In that installation moderately heavy grading took place during clearing of the area, which was then planted in grass. Rather rapid runoff took place just below the surface at approximately the plane of the undisturbed earth. Potential ponding problems were created on the adjacent property and it was necessary for the developer to construct intercepting ditches to avoid serious complaints. This problem has not occurred in the other installations presently existing.

Chemical characteristics of the waste can also have a significant effect on a spray field, particularly if the soil contains considerable

determining the suitability of water for irrigation of Western soils:

$$\% \text{ Na} = \frac{\text{Na} \times 100}{\text{Ca} + \text{Mg} + \text{Na} + \text{K}}$$

(where cations are in gram equivalents per million).

To be suitable for irrigation of western soils, the equivalent percentage of sodium should not exceed 80 nor should the total concentration of cations exceed 25 gram equivalents per million. It is recommended, particularly on clay soils, that the spray field be given an occasional treatment with agricultural lime in order to compensate for the effects of the above factors on the soil.

Undoubtedly, the effluent serves as a fertilizer source (especially of nitrogen and phosphate) for the vegetation cover of spray fields;

however, it is unlikely that the plant cover can retain more than a fraction of the nutrient solutes. The high phosphate content of the effluent will be reduced after passing through the soil but only for a time. When phosphate adsorption on soil particles reaches saturation, the phosphate will enter the ground water. This had been noted in ground water tests carried out at our Cascade Utilities installation. In these tests it was also notable that the degree of bacterial contamination of the ground water was very low, with the average MPN values for coliform groups ranging from 0 to 23. These values are well within the values normally expected from shallow ground waters.

Mechanical considerations, especially with regard to selection of nozzle types, are important. Mechanical injury, due to the impact of the spray on foliage, seemed greatest where the relatively high-pressure jogging type of sprinkler nozzle was used. In addition to causing necrosis in leaves, low herbaceous vegetation (grasses, etc.) were beaten down by the force of the spray. Such damage did not seem so significant with the low-pressure type nozzle installed in our projects. In addition, the low-pressure nozzle, of course, results in significantly lower pumping costs.

Another mechanical consideration to be evaluated is the distance to be maintained between the nozzles and the fence surrounding the field. In this area, the regulatory agencies have tentatively approved a 150-ft. distance though this is certainly a factor where more extensive research would be desirable.

Good and sensible maintenance should also be performed on any spray field. The blooms of algae that darken vegetation were seen locally at only the Lake Hills site. Stumps at that site showed a significant coverage of algae blooms. It is suspected that this is not an invariable result of spraying sewage effluent. It is more likely the result of too much volume, spraying too often, and possibly chemical effects of improperly treated effluent, etc. Alternating by the week on spray areas such as at Cascade Utilities (S.E. of Renton, Washington) is apparently a sound practice as it allows good aeration, minimizes algal scum and seems to be generally working well in practice.

Treatment

The raw sewage in each of the installations involved has been of a domestic type with a BOD usually in the range of from 200 to 350

mg/L. The suspended solids in the sewage have been in the same range of values. With primary treatment given the sewage prior to spraying, the sewage to be sprayed had a BOD of from 100 to 200 mg/L. Again, solids values were of the same order of magnitude.

Establishment of the specific degree of treatment required prior to spraying was a responsibility assumed by the regulatory agencies. However, the requirement of primary treatment seems a logical selection when one reviews the literature on industrial installations. From them, it can be noted that the degree of treatment is not highly critical, with regard to BOD anyway, since many canneries spray the raw wastes after merely screening them to prevent entrance of large material which would clog the nozzles. Spraying of raw domestic sewage would not seem particularly logical due to the significant amount of large solids and grease essentially removed by primary treatment, but which very probably would cause significant problems in soil clogging and rather odorous decomposition on the spray field. The systems installed with primary treatment seem to be working well with only one exception. In that case, a temporary installation was rather severely overloaded and resulted in excessive sludge and probably grease carry-over which crusted upon and apparently clogged the soil in the spray field. Nearly all vegetation died before the installation was removed from service.

Other treatment systems are being considered for use with spray fields, however. One system is just now being installed which will spray domestic wastes following its treatment in a single stage trickling filter installation. The technical reasons for providing secondary treatment in that installation, however, are not apparent. There is another installation under construction consisting of a lagoon the effluent from which will be sprayed for disposal. This installation is at a U. S. Army Nike site where it was determined that construction of a lagoon would be less expensive (since property already owned by the government was available) and would result in simpler maintenance than a conventional primary plant. The lagoon was designed on a conventional basis.

Application Rates

Certainly, every spray field must be designed on an individual basis. In our installations, soil logs, perco-

lation tests, water penetration of the surface and type of vegetation were evaluated in arriving at the spray field design. In the Providence Heights College installation, the soils generally consisted of one foot of sandy top soil with some gravel underlain by from 2 to 4 ft. of sand and gravel with some clay. Under this was found hardpan consisting of $\frac{3}{4}$ in. or less of gravel lightly cemented with a major portion of sand and a little clay. The vegetation in the area consisted mainly of alders with wild blackberry vines aggravating the problem of surveying the area. This unit is just being completed with the specifications allowing only sufficient thinning for installation of the sprinklers and to allow reasonable distribution of the spray from the heads. Actual spray application rates in this field will be approximately 0.44 gal. per sq. ft. per day or about 160 in. of moisture per year plus normal rainfall. In this Seattle area the normal rainfall averages approximately 30 in.

At the Cascade Utilities site, the soil generally consisted of 6 in. of organic humus underlain by $1\frac{1}{2}$ to 3 ft. of light brown, loose, slightly silty sand loam with some gravel up to 3 in. in diameter and with roots extending to 24 in. deep. This was underlain with 2 ft. or more of fine light gray sand and gravel with some silt all of which was compact but not cemented into hardpan. The vegetation in the area consists of firs and cedars but with a predominance of alder and a few miscellaneous species. The application rate in this field, which has been in operation approximately $1\frac{1}{2}$ years, is about 1 gal. per sq. ft. per day or 360 in. per year plus normal rainfall of approximately 30 in. per year. The gross area of this spray field is approximately 7 acres.

The St. Edwards Seminary site which has been in operation for approximately $2\frac{1}{2}$ years, had even freer draining soils than either the Providence Heights College or the Cascade Utilities sites. The percolation tests indicated this soil would be classified as "rapid absorption" soil by the standards established by Ramsey and Sleeper. The vegetation cover consisted again of second growth evergreens but with a predominance of alder and with smaller wild shrubs. Accordingly, the design loading of this spray field was approximately 2.25 in. per sq. ft. per day. However, it has not been loaded to design capacity yet because the housing developments which this unit will serve are not yet complete. The average to date

has been approximately 0.62 in. per day or 220 in. per year plus normal rainfall. The facilities have been working exceedingly well.

At the Vashon Nike site, spray disposal will follow treatment of the sewage in an oxidation pond. The available area upon which a spray irrigation system could be constructed, consisted of an abandoned orchard with a substantial growth of native grass. The orchard trees were cut down several years ago and the area essentially left unused. From an evaluation of this site including the use of percolation tests and surface absorption rate tests, a design loading of approximately 0.26 gal. per sq. ft. per day or 94 in. per

rate pump headers to the respective sections of the spray field. Others use a single header with the various sections of the spray field separated by means of valves. In the latter installations, the general practice is to operate one bank for approximately one week, then reset the valves to rest that area and operate another bank approximately one week. This latter practice seems to be working particularly well.

General Recommendations

Under a regimen of controlled quantity and quality of effluent, as well as proper consideration in the design of spray fields, a reasonably good vegetation cover can be ex-

spected to survive and even thrive. This has certainly been shown at the installation at St. Edwards Seminary near Kenmore, Washington, and at Cascade Utilities, a housing development of approximately 740 homes. The St. Edwards Seminary site is now approximately 2½ years old and the Cascade Utilities site approximately 1½ years old. Certainly experience in their operation will be of considerable value and a guide in designing new installations. However, a number of possible planting and/or vegetation management plans can be envisaged for the following conditions:

Type of Site

1) **Wooded Areas:** While there no doubt will be certain differences of opinion, it would appear that installation of a sprinkler system in wooded areas would be a practical and recommended practice where

spray irrigation is to be accomplished and where wooded areas with proper species of vegetation are available. Stump holes and local depressions which would cause ponding should be filled to prevent nuisance and mosquito breeding. The sprayheads themselves should be placed judiciously to secure reasonably uniform distribution of the effluent in the woods. This might require selective thinning but the thinning should not be so complete that the areas within the operational radius would be devoid of trees. Periodic selective thinning and brushing will probably be necessary to prevent spontaneous growth from exceeding the height



● **TYPICAL** grassed spray area. Satisfactory operation is possible where there is a reasonable cover of natural grass.



● **SEDGE** grass, shown here, is particularly suitable for the wet conditions that must exist for long periods in a field.

year of applied moisture plus normal rainfall was established. The gross area of this spray field will be approximately 1.58 acres.

Of necessity, all installations operate throughout the year. Certainly this results in higher application rates in the winter than in the summer but so far no significant problems have resulted. If such problems do develop, it will be a relatively easy matter to reduce the unit loading by moving the aluminum pipe to provide wider separation of the nozzles.

Most of the spray field installations were designed with multiple banks of nozzles so that the various banks would alternate in their operation. The period between alternations varies widely from field to field. Some alternate each time a pump comes on through installation of dual pumps equipped with an automatic alternator and sepa-

of the sprinklers. If artificial planting should become necessary (which is doubtful) there are tree species and suitable shrub species for this Puget Sound region. Herbaceous vegetation including Sedge grass should invade rapidly as evidenced at Cascade Utilities.

2) **Cultivated Areas (Abandoned pastures, orchards, etc.):** In such areas there appear to be three possible courses. Where a reasonable cover of natural grasses exists a significant number of industrial applications have indicated artificial plantings to be unnecessary. Weeds and flourishing other grasses have provided adequate cover. This would certainly be the least expensive form of installation. If this does not prove satisfactory, or if another type of cover is desired, it may be possible to hand sow the desired seed. If this is to be done it would probably also be desirable to hand

sow a reasonable cover of hay to prevent significant seed losses to the birds. As a third alternate, or supplement, it is also, of course, possible to plow, fertilize and specially seed the proposed spray field area. The Lake Hills site is one in which this was accomplished. If possible, it would probably be desirable to allow the plowed and seeded area to accomplish some growth before the spray application is begun. The problem would be merely one of physical washing of the seed and soil if such advance growth were not permitted.

Maintenance of Sites

1) It would be desirable to obtain pH tests of the soil prior to the start of spraying operations and to obtain periodically pH tests of the sprayed and adjacent unsprayed soils to determine whether spraying is significantly affecting the soil characteristics. If a significant change is noted proper chemical application would be in order for correction.

2) If the crops are to be either native or spontaneous vegetation

they should be periodically cut back to prevent interference with the spray nozzles. If the cut material is excessive it would usually be advisable to move it out of the spray range to prevent algal and fungal accumulations. If the crop is to be forage grass, it should be moved, raked and removed at least twice in the growing season. Reasonable personal care should be taken because the grass may be significantly contaminated. In all probability, it should not be used for either human or animal consumption though this is a matter for additional research. Burning would seem in order at this time.

Plant Lists

There are a considerable number of plants composed of native or introduced species as well as cultivated species which appear to be suitable as vegetation cover for spray fields. However, they should be carefully selected by people experienced in this particular problem and for the particular site involved. Certain species of trees both evergreen and deciduous as well as par-

ticular shrubs and grasses could be used. The list of vegetation will certainly become more specific with the additional experience and research that is continuing.

It is recommended that full advantage be taken of all data and experience available if and when it is desired to take any steps in regard to any particular spray field.

Particular acknowledgement should be given Dr. A. R. Kruckeberg and Dr. Richard Walker, Consulting Biologists, and Ernest F. Dodge and H. H. Chenoweth, both registered professional engineers and respectively design and project engineers in our organization, who have been directly involved in the project designs and research supervision for this work.

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NEW ENGINE PAY DIVIDENDS IN REDUCED FUEL COSTS

THE MUNICIPAL power plant at Sabetha, Kansas, has a long record of economical diesel operation that has afforded its customers rates that are among the lowest in the state. Since the installation of a 2100-hp Fairbanks-Morse dual-fuel engine in January 1957, the operating picture has been further improved. Fuel costs per kilowatt hour have been cut by 11½ percent; total production costs by just over 7 percent.

That these cost reductions reflect the greater efficiency of this latest engine is evident in the engine-hour and kilowatt-hours-generated figures. During its first two years, 1957 and 1958, the engine accounted for 72.4 percent of the power generated, or more than 13 million kwh out of the plant's total of about 18 million kwh. Up to June 1, 1959, this engine had run 18,595 hours out of a possi-

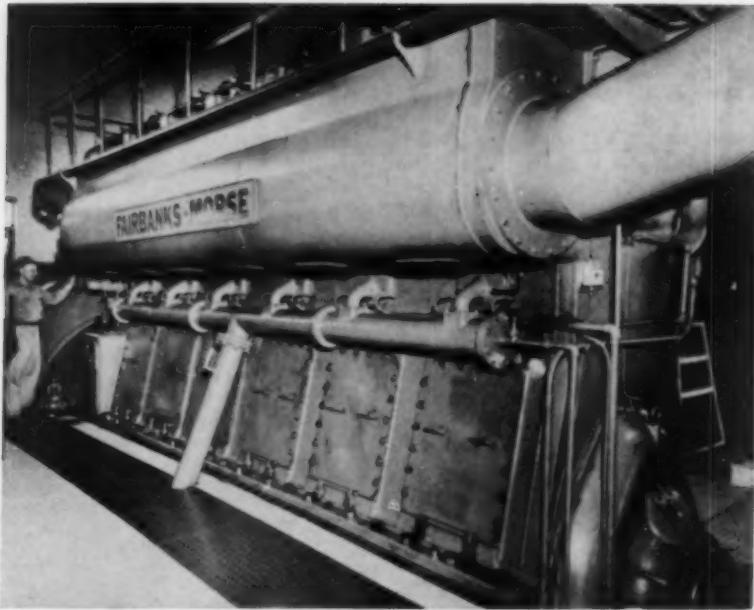
ble 20,976 hours, or 90 percent of the time. Except for a routine shutdown every 600 to 700 hours for preventive maintenance, this engine has run continually since January, 1957.

This newest engine at Sabetha is a 6-cylinder, 2100-hp, Fairbanks-Morse dual-fuel unit direct-connected to a 1500-kw, F-M alternator with silent chain-driven exciter. Its addition brings plant capacity to 3906 kw, ample to handle the peak load, which reached 2440 kw in 1959, even should one of the big engines be out of service.

This firm capacity is vital to Sabetha today for its major industries depend upon unfailing power, with peak demands coming in July and August when air conditioning and farm use are also heavy. Peaks are reached again in January and February. Sabetha, a community of

2,300, is the site of the largest farm-owned creamery in the world, the Nemaha Cooperative Creamery, a producer of butter, ice cream, and powdered, condensed and whole milk and is in the heart of a rich agricultural area. For the past 30 years the surrounding rural areas have been electrified, getting their power from the Sabetha plant. The rural power demand is heavy with 100 miles of rural line, the small nearby town of Morrill and the farmer-owned Berwick Transmission Line Company, all served by Sabetha's municipal plant, accounting for about 27 percent of power sales in 1958.

The number 1 engine in the present plant is a 875-hp, 606-kw diesel installed in 1937. Between 1937 and 1947 demand for power increased by 105 percent and, in 1947, a second diesel was installed, a 1200-hp, 840-



● NEWEST and largest engine in the Sabetha plant is shown here, with Homer Bechtelheimer, plant superintendent at the extreme left. New engine has cut costs.

kw unit. Three years later, with kilo-watt-hour production up another 25 percent, from 3,900,000 to 4,900,000 kwh, a 1400-hp, 960-kw diesel was added. This brought total capacity to 2406 kw which was sufficient to handle peak loads, even with the biggest engine out, until 1954. In that year the peak load reached 1560 kw; kilowatt-hour production, 6,800,000. Only in 1957, when the latest 2100-hp dual-fuel went into operation, did the plant again have a firm capacity.

The compactness of the engine design made it possible to install a 1200-hp unit in the space formerly occupied by the plant's old 360-hp engine and the new 2100-hp dual-fuel, in the place of a 600-hp engine.

Today, all but the oldest, the 875-hp engine, operate as dual-fuel units. The 1200 and 1400-hp engines were both converted in the field. The first was adapted to dual-fuel operation in 1950 in anticipation of the availability of natural gas. The 1400-hp unit was changed over in 1952 when gas became available. The only time the plant operates on straight diesel fuel is during the gas consumer peak loads in coldest weather. Cut-off at those times, however, has never exceeded 30 days in any single year.

Natural gas is piped to Sabetha from the fields of Oklahoma, Texas, Kansas, and from underground storage. Rated at from 975 to 1000 Btu, it reaches the plant at about 35 psi and is reduced by pressure

regulators, reaching the engines at 31 psi. A single meter serves the entire plant.

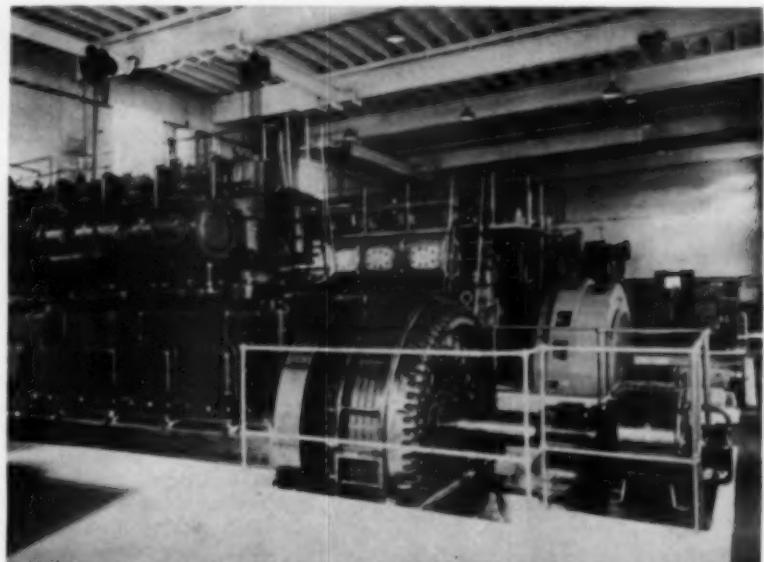
All four Fairbanks-Morse engines use special diesel fuel which has a 28-30 grav. API. Delivered by tank car, it is stored in one 15,000-gal. underground tank and one 10,000-gal. above-ground tank prior to delivery to the individual engine day tanks.

The entire plant employs the same closed cooling water system with its

atmospheric cooling tower for the raw water circuit. Shell and tube heat exchangers and oil coolers are used for all but the oldest diesel. Two F-M centrifugal pumps handle the water between exchangers and cooling tower and one pump raw water to the oil coolers. There is a separate pump for the jacket water circuit of each engine.

During 1958, the last full year of operation, Sabetha's power plant generated a total of 9,415,700 kwh, largest total in its history, and had a gross revenue of \$165,407.95. Yet the citizens acquired this valuable 3,906-kilowatt plant at a cost of just \$10,000. That was the total of the bond issue voted in 1901 for the start of a municipal electric system. All subsequent purchases have been paid for out of profits based on economical power production—savings which have been increased by 11½ percent since the installation of the newest 2100 - hp Fairbanks - Morse dual-fuel diesel.

Prominent among those who have built the Sabetha plant to its present level of efficiency and profit is former City Engineer C. A. Darby. The Sabetha Municipal Electric System is currently being directed by Mayor Donald R. Jones; Arlie Gilbert, Commissioner of Finance; Harvey E. Lukert, Commissioner of Streets and Utilities; Alma Aberle, City Clerk; and department executive David E. Vancil, City Engineer and Manager of Utilities; Homer Bechtelheimer, Plant Superintendent; and Arthur Gates, Distribution Foreman.



● INTERIOR view of the Sabetha power plant which houses four Fairbanks-Morse engines, ranging in size from 875 hp to the new 6-cylinder 2100-hp dual fuel.

RURAL COUNTY BUILDS LOW COST ROADS



● SOIL-CEMENT base for County Road "T" was built in October, 1959, and given a seal treatment. Here is how it looked.

KARL MOHR

County Engineer,

Fulton County, Ohio

PEOPLE often wonder how a small county like ours can carry out an extensive program of rural road improvement. Nearly half of the county road mileage has been paved during the past eight years. Also many township roads have been paved through arrangement with the local township trustees. Total construction in an eight-year period has amounted to about 150 miles of road, all built with sound base and all-weather surface.

Main factors in holding down costs have been 1) use of force-account labor and county equipment; 2) simplified engineering; and 3) wide use of soil-cement bases and low-cost surfaces. It is costing Fulton County less than \$10,000 a mile to build an 18-ft. soil-cement road complete with double seal surface.

Most of the work has been done with county highway department labor using county-owned equipment. Projects built by contract have amounted to less than 20 miles of road, mainly federal aid jobs and others that included major structures or relocations. Our own road crew has done all the rest.

Where existing road materials are granular, as in most parts of the county, soil-cement is the favored type of construction. Stabilization is accomplished by adding approximately 10 percent of cement by volume. About 12 percent cement is

needed in clay soils and 15 percent in muck, but in most cases stone bases have been built where high cement factors would be needed for soil-cement. Soil-cement is processed to a depth of 8 in., which compacts to a 6-in. base.

During the construction season the county has eight or nine men at work on the soil-cement crew. Most of these have been on the job for several seasons and are thoroughly acquainted with the work. They do their jobs without a foreman in the field, each man carrying out his own task. All that Robert Badgley, road superintendent, needs to do when a project is underway is to visit it once or twice a day to check progress, to see that equipment is in operating condition and to schedule the next day's deliveries of material.

Equipment Used

Equipment consists of general-purpose machines rather than special types. Many pieces are quite old but still efficient. We aim to get full use of every tool we buy. The following equipment is used for soil-cement construction: Cement harrows pulled by farm tractors and 2 portable square-cornered 2,000-spreader, 2 graders, 2 spring-tooth gal. steel water tanks with home-made gravity-fed spray bars (tanks are carried on regular dump trucks). In addition we have a pulverizer, a sheepfoot roller pulled by diesel crawler, a 10-ton steel roller and a rubber tired roller.

This crew and equipment can build about 1,800 ft. of road a day.

That's the usual amount that can be processed with four truck loads of bulk cement.

In order to avoid loss of time it is important to get cement spread as early in the day as possible. To do this, the section of road to be processed on any given day is scarified on the day before and moistened in the evening if dry. Arrangements are made with the cement company to have two bulk cement trucks at the job when work starts at 7:00 a. m. Two more trucks come on the job an hour or so later.

The spreader is attached to the rear of the first truck and cement is applied to one traffic lane at a rate of 5 percent cement by volume—half the amount needed. A dump truck or grader tows the spreader back to the starting point where it is then attached to the second truck. The second truck passes over the same lane covered by the first truck, spreading the rest of the cement needed for a 10 percent mix. Then two more loads of cement are spread in the second lane.

At first the men tried to put down all the cement in a single pass, but they found this difficult because bulk truck screws would not deliver cement to the spreader fast enough. So time is saved and a more even distribution of cement is obtained by spreading in two passes. Spreading of cement is usually completed by shortly after 10:00 a. m.

Dry mixing with soil begins immediately after spreading. An equipment train of two graders, two spring-tooth harrows and the pul-



● TWO GRADERS and two spring-tooth harrows follow the cement tanker. Cement is mixed into the soil to a depth of 8 ins. Compaction follows mixing operation.

verizer trails the cement truck on the last pass. The graders scarify the tracks left by the truck and spreader box. The harrows and pulverizer begin the mixing process. When the end of the section is reached, one grader operator proceeds to the section ahead and scarifies the area that will be processed the next day.

By getting cement spread early and dry mixing done quickly, about two-thirds of the working day remains for the operations that consume the most time, namely wet mixing and compacting. These operations also are carried out in a work-train manner. Water truck, spring-tooth and pulverizer pass in that order. As soon as a water tank is emptied, the driver goes for a refill. Meanwhile, the spring-tooth and pulverizer operators continue to mix the material thoroughly until the proper moisture content is reached.

Next the mixture is compacted with the sheepfoot roller, with repeated rolling until compaction is complete. Then compacted soil-cement is shaped with the grader blade, lightly dragged with a spike-tooth harrow, and finished with a roller. Either a rubber-tired or steel-wheel roller may be used. It is normally unnecessary to use both. After rolling, the finished road base is given frequent sprinkling until curing is applied.

When base construction has been completed on the whole length of a project, a coat of rapid seal emulsion is applied. This is done on the final

day of processing. Then 0.35 gal. of asphalt emulsion is applied with 10 lb. of No. 9 stone to prevent pick-up of the primer.

The wearing surface is applied shortly after, within a week if possible. This consists of two courses of medium curing asphalt and No. 6 stone. The first course consists of 0.35 gal. of asphalt and 25 lb. of stone, the second course 0.4 gal. asphalt and 25 lb. stone.

During the first two years of soil-cement construction in Fulton

County, roads were surfaced with T-32 (road-mixed bituminous surface course). The double seal, which costs only half as much, was tried later as an experiment. It was considered a temporary surface to be built up later with something better, perhaps T-32 or T-35 (plant-mixed bituminous concrete). But to date no patching has been required in the double seal surface on soil-cement roads. So it seems prudent to continue using the double seal as a permanent surface.

Engineering and testing details are held to a minimum. No grade lines are established or profiles



● THIS SPREADER is applying bulk cement to the prepared road base. The author, right, watches the progress.



● WATER TANK mounted on a dump truck provides a gravity-fed spray to moisten the soil cement. Rotary pulverizer at right continues to mix materials thoroughly.

drawn for force-account projects since the county's relatively level terrain permits adhering to existing traffic-bound grades. Estimates are prepared on the basis of length of work and observed field problems and soil characteristics. Laboratory tests are made only in unusual circumstances.

When a job starts, an engineer stakes out the starting and finishing points and provides running stakes about every 150 ft. to serve as a guide for width and direction. It is seldom necessary to test samples in the field while soil-cement work is going on because experience has taught the workmen how to judge when optimum conditions are reached and how to adjust quantities and methods to reach them.

More than 60 miles of soil-cement paving have been done in Fulton County since 1950. This includes county roads, township roads, and village streets. In the case of township and village jobs the local subdivision pays for the materials.

The cost of soil-cement construction has averaged about 90 cents per sq. yd. This includes engineering, material and labor costs for both base and surface. Costs have remained fairly constant over the entire period.

When the county began building soil-cement roads in 1950 it was expected that resurfacing would be necessary in a few years and that there would be occasional need for patching. But things haven't worked out that way. All of the surfaces have held and it appears now that it will be some time in the future before the first patch is needed.

• • •

Chicago's Southwest Pumping Station

Chicago will place an ultra-modern water pumping station in operation on the Southwest Side in 1961. The new station will have an initial capacity of 175 mgd, and will be boosted to 275 mgd when demand increases. The Southwest station will serve 250,000 users in Chicago and 11 suburbs.

The contract requires the builder to complete work by April, 1961. This task includes construction of foundations, superstructure and pump wells and installation of valves, discharge piping, a 30-ton crane, pumps, plumbing, heating, ventilation, the dehumidification and electrical systems, and grading and roadway work.

The station will be 151 feet long, 120 feet wide, and built without

deep and costly pump pits. The pits will be eliminated through the use of vertical submerged-type turbine pumps. Three such pumps having a capacity of 50 mgd each, and one of 25-mgd, are being manufactured by Byron Jackson Pumps, Inc., of Los Angeles at a cost of \$330,000. The larger pumps will be turned by 2250-hp motors, the smaller by a 1250-hp unit.

The pumps will discharge water from the 12-foot diameter Columbus Avenue tunnel, now under con-

struction. Filtered water from the South District Filtration plant, will flow into the Columbus tunnel from an existing tunnel in 73rd St. and Western Ave., then into the station.

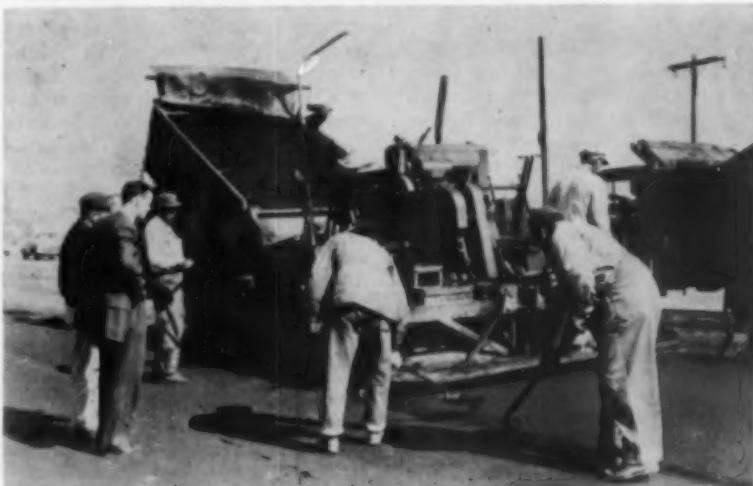
Southwest was designed by the firm of Alvord, Burdick and Howson, engineering consultants. The apparent low bid of \$1,307,000 for the station was submitted by the Paschen Contractors Inc. With the pumps and switchgear under separate contracts, the total cost will be \$3,000,000.

DEVELOPMENTS IN ASBESTOS-ASPHALT PAVING MIXES

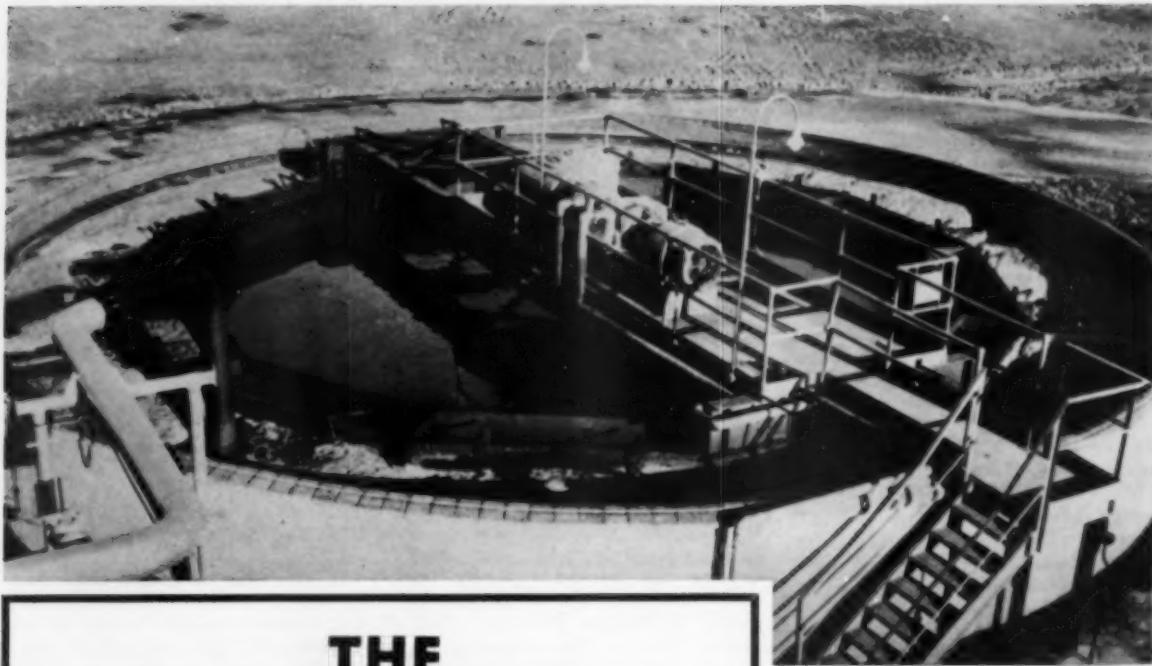
EXPERIMENTAL tests have indicated that substantial benefits in paving life, performance and maintenance can be achieved by the addition of only 2 or 3 percent by weight of asbestos fibre to asphalt paving mixtures. Not every type of asbestos fibre is suitable for asphalt paving applications, but the special grade of fibre required is available in quantities far exceeding present demand. The asbestos-asphalt paving mixes, because they allow the use of greater asphalt proportions, give a tough road surface with resistance to indentation under heavy load and high temperatures, less brittleness under low temperatures, more flexibility, resiliency and resistance to cracks resulting from exposure to all kinds of weather. Johns-Manville, in cooperation with federal, state and municipal highway departments and private contractors, has assisted in the laying

of 18 test strips, subject to typical vehicular traffic, in 8 states and the Province of Quebec, Canada. Highway specialists have been impressed by results to date and are introducing asbestos-asphalt mixes on an experimental basis as part of their current paving projects.

Asbestos-asphalt highway strips are now being tested at Buffalo, N. Y.; Manville, N. J.; Cincinnati, Ohio; Detroit, Mich.; St. Louis, Mo.; Denver, Colo.; Dallas, Tex.; Oklahoma City, Okla.; and Sherbrooke, Quebec. An asbestos-asphalt service road in Quebec, Canada, was installed in 1953 and for six years was subjected to service by heavily laden ore trucks in weather conditions highly damaging to conventional pavings. Adjacent asphalt paving, without asbestos fibre, has required more costly maintenance during the period than the asbestos-asphalt test strip.



● TYPICAL strip of asbestos-asphalt paving, one of 18 now under test, has 2 to 3% by weight of asbestos fibre to give a tougher, more maintenance-free surface.



THE COMPLETELY-MIXED ACTIVATED SLUDGE PROCESS

A. A. KALINSKE,
Vice President and Technical Director,
Infilco Inc.,
Tucson, Arizona

THE ACTIVATED sludge process for sewage treatment has been used now for some 40 or 50 years. Until recently, the application of this process was limited primarily to domestic sewage, and treatment plants were designed using "rule-of-thumb" design factors. Only within the last decade or so has the nature of this process been studied to establish basic, quantitative design criteria and to determine the factors which make possible its most efficient application technically and economically.

Many of the recent basic studies in connection with the activated sludge process have been made by applying the process to the treatment of various types of organic industrial wastes. The designing of biological waste treatment plants for industry

is less hampered by so-called standards set up by regulatory agencies. Therefore, vast strides have been made in broadening the application of the process and in establishing correct scientific design bases. The incentive to reduce capital investment is, of course, tremendous when it comes to industrial waste treatment. The "completely-mixed" activated sludge process, which affords significant economies from a capital investment standpoint, has been adopted for domestic sewage treatment plants quite slowly; however, engineers concerned with designing and building industrial waste treatment plants have been quick to realize the advantages that this completely-mixed system affords.

This article describes briefly the history of the development of this process, and how it is now being applied both for domestic sewage treatment plants and for industrial wastes treatment plants, both where such wastes are treated alone and in combination with domestic sewage.

● **COMPLETELY mixed system permits biological loadings 4 to 6 times greater than in conventional types of plants.**

It has now been fairly well established by various investigators that there is no benefit in employing the process in the form of a cyclic system, wherein the organisms are over-fed at one stage and then are gradually allowed to become starved and depleted of oxygen before they are reused in the process. This basically is what has been done in the conventional activated sludge treatment process described in our textbooks.

The basic disadvantages of such a cyclic process were pointed out in a 1950 article (1). It was indicated that if all the organisms in the system were fed uniformly, and kept at all times in the presence of dissolved oxygen, much higher biological loadings and treatment rates could be achieved. Data were presented on pilot plant studies using the completely-mixed system. Further pilot plant studies were reported in 1956 (2), and the fundamentals were outlined. Since that time this process has been further analyzed by McKinney and his associates (3). Stack and Conway (4) studied it in connection with establishing design criteria for a large treatment plant for domestic sewage and complex dissolved organic wastes from a chemical manufacturing plant.

In brief, the completely-mixed system provides ideal conditions

since the organisms are kept in a constant and uniform state of growth. This is obtained by mixing the raw sewage or waste completely and quickly with all the organisms in the system, and then continuing to add the raw waste so that no localized high concentrations are present. The BOD level in the aeration basin or compartment is essentially equal to the effluent BOD. Therefore, organisms are not subjected to appreciably stronger wastes at any point for any significant period of time. Some of the organisms which are dying are continually releasing nutrient materials, and in such a homogeneously mixed system this release and the demand for nutrients occur at the same point. Pilot plant and full-scale data obtained under controlled conditions have indicated that in a completely-mixed system biological loadings can be used that are 4 to 6 times greater than in the conventional activated

sludge treatment process. For example, domestic sewage BOD loadings up to 300 lbs. per day per 1000 cu. ft. of aeration volume, or up to 1.5 lbs. of BOD per lb. of mixed-liquor solids per day are possible.

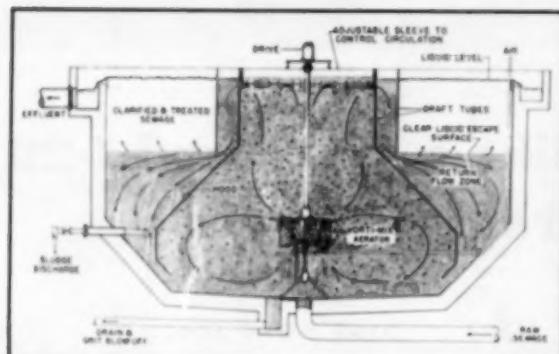
Liquid-Solids Separation

One of the necessary steps in the activated sludge process is the separation of the treated liquid from the suspended biological solids. In the conventional system this is accomplished by transferring mixed-liquor solids in the aeration basin to a gravity-type settling and clarification unit. In order to reduce the amount of pumping necessary for recycling the settled solids to the head end of the plant to mix with the incoming raw sewage, it was frequently attempted to accomplish a considerable amount of thickening of the settled sludge in such clarification equipment. This meant that the biological solids were kept away

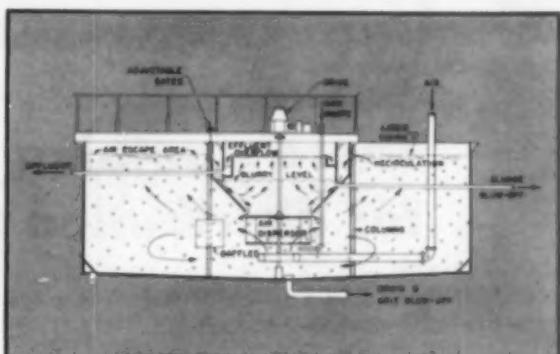
from any dissolved oxygen for as much as an hour and more. This was undesirable, since aerobic organisms cannot maintain their vitality for any length of time in the absence of dissolved oxygen. This apparently was realized quite early in connection with the application of the activated sludge treatment process, and as a result reaeration of the returned solids was brought into the general scheme. Such aeration was necessary in order to return vitality to the organisms so they could function properly when again mixed with the incoming raw sewage.

Ideally, the liquid-solids separation should be accomplished as quickly as possible to avoid depleting the dissolved oxygen in the liquid fraction. Of course, such ideal conditions are somewhat impractical to obtain, and therefore, we can only approach them, but we must ap-

(Continued on page 241)



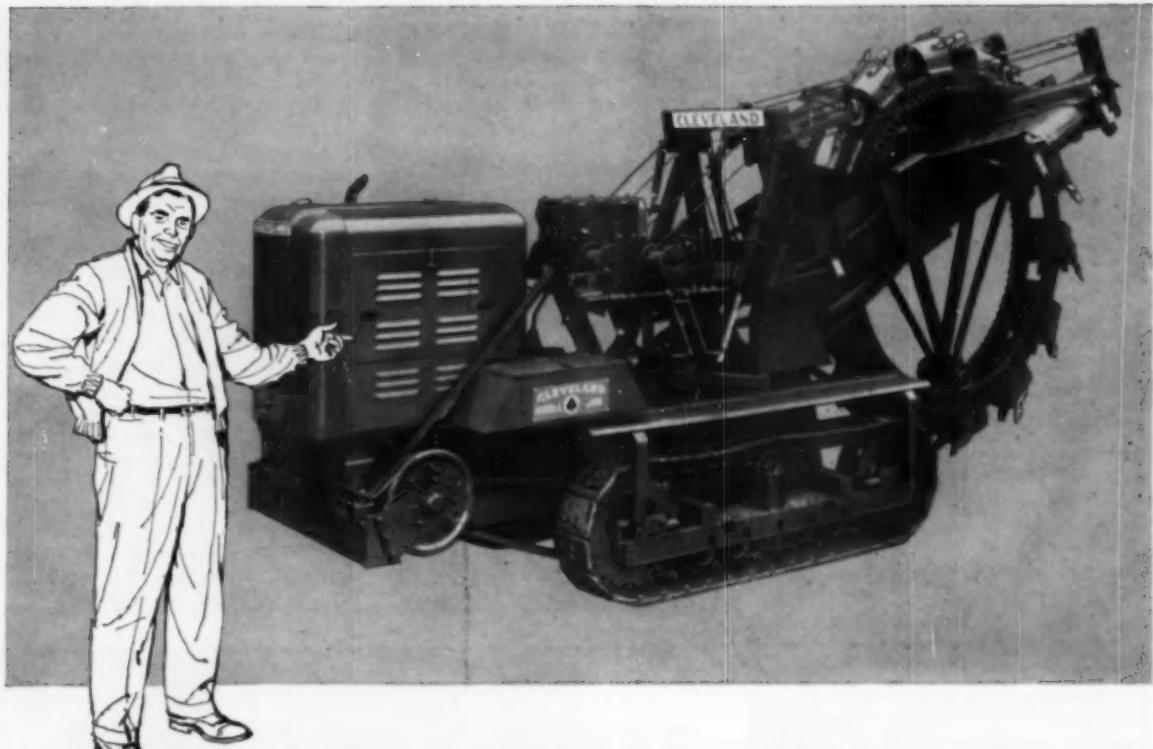
• THIS is the Aero-Accelerator treatment unit Type AR.



- THE TYPE 10 unit reverses some features of Type AR.



• ATTRACTIVE plant at the General Petroleum Co. plant in Fendall, Washington utilizes the Type 10 Aero-Accelerator.



There's nothing like a Cleveland J-20 for distribution trenching

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- hydraulically shifted conveyor.
- pulley-enclosed dual conveyor drive.
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NEWS BULLETINS

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Transportation Committee Announced

Chicago, Ill.—John Bailey, Deputy Managing Director and Executive Director, Urban Transportation Study Commission, Philadelphia, Pa., has just been named chairman of the American Public Works Association's Transportation Committee according to APWA's President Jean L. Vincenz.



Mr. Bailey

Urban Transportation. Since that date the National Committee has developed a series of authoritative publications covering the basic elements of a comprehensive urban transportation planning program. Many of the publications, or guide manuals, are of particular interest to public works officials.

APWA's Transportation Committee has been established to develop appropriate means of acquainting public works officials with the program sponsored by the National Committee on Urban Transportation. And, perhaps, a more specific function will be to give public officials a working knowledge of the tech-

niques, standards and procedures described in the manuals.

Others who have accepted appointment to this committee include:

Grant D. Mickle, Director, Automotive Safety Foundation, Washington, D. C. (Secretary); Glenn C. Richards, Commissioner, Department of Public Works, Detroit, Mich.; Eugene Maier, Director, Dept. of Public Works, Houston, Texas; Edward N. Hall, Director, Transportation Research, San Diego, Calif.; C. G. Stoneburner, Highway Engineer, Arlington, Va.; E. E. Lewarch, Traffic Engineer, Engineering Department, Seattle, Wash.; Albert J. Wyler, Director of Streets, New Orleans, La.; and Fred J. Benson, Director, Texas Transportation Institute, College Station, Texas.

New APWA District Representatives Announced by President Vincenz

Chicago, Ill.—President Jean L. Vincenz has recently announced the names of fifteen new appointees to act as District Representatives for the American Public Works Association in the various Regions set up across the United States and in Canada. The District Representative is a key official in the organizational structure of the APWA.

His job is a varied one with considerable responsibility. In his role as a representative of the Association, he assists the APWA in its ob-

jectives of working toward improved management practices and techniques and increased efficiencies in governmental operations regarding public works. He serves as a point of contact between the members and chapter officers, if any, in his district and between the officers and staff at the headquarters. He serves as good will ambassador for the APWA by establishing a close working relationship with colleges and universities in his district and with other officials in the district who are directly or indirectly concerned with the broad field of public works.

It is his responsibility to collect and submit news items to the headquarters office, and to make a quarterly report to the Regional Director. He assists in coordinating membership campaigns and helps publicize local chapter activities.

There are a total of 64 public works officials serving in this capacity in nine separate regions of the Association. The fifteen new officials appointed to this office by President Vincenz are:

Timothy J. O'Leary, General Superintendent, Sanitary Division, Department of Public Works, Boston, Mass.

Francis J. Laverty, Superintendent, Department of Public Works, Ithaca, N. Y.

William E. Sacra, Jr., Supt. of Sewage Treatment Works, Dept. of Streets & Public Improvements, Harrisburg, Pa.

OFFICERS: Jean L. Vincenz, San Diego, Calif., President; Frederick W. Crane, Buffalo, N. Y., Vice President. **REGIONAL DIRECTORS:** (term ending 1960) Charles W. Cooke, Hartford, Conn.; R. S. Hopson, Richmond, Va.; H. H. Hester, Fort Worth, Texas; (term ending 1961) Louis H. Moehr, Wyandotte, Mich.; John A. Morin, Oakland, Calif.; W. A. Bowes, Portland, Ore., (term ending 1962) Paul R. Screvane, New York, N. Y.; Albert G. Wyler, New Orleans, La.; Edward J. Booth, Bismarck, N. D. **Immediate Past President**, Wm. D. Hurst, Winnipeg, Manitoba. **Robert D. Bugher**, Exec. Director.

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Henry M. DeNoble, Traffic Engineer, City Hall, Little Rock, Arkansas

Manon P. Phillips, Commissioner of Public Works and City Engineer, Augusta, Georgia

Lawrence E. Crandall, Asst. Director & Asst. City Engineer, Department of Public Works, Battle Creek, Mich.

D. F. McCarthy, Director of Engineering Division, Toronto, Ontario

Harold F. Harper, City Engr., Salina, Kansas

R. E. Bragstad, City Engineer, Sioux Falls, S. D.

W. A. Satterwhite, Jr., Chief Engr., Dept. of Public Works, Fort Worth, Texas

Michael J. Carozza, Director of Public Works, Fresno, California

Hideshi Iwamoto, Engineer, State Department of Public Works, Honolulu, Hawaii

R. P. Sauer, Director of Public Works, Las Vegas, Nevada

H. R. Cameron, Municipal Engineer, Richmond, British Columbia

Emerrick Huber, City Engineer, Casper, Wyoming

1960 Nichols Award Nominations Are Now Being Received

Chicago, Ill.—Nominations for the Charles Walter Nichols Award are now being received by the Award Committee headed by Hugo Erickson of Minneapolis, Minnesota. Several candidates have already been recommended for the award; the deadline for all nominations is June 15, 1960. Any member of the APWA may nominate candidates for this award.

The award is presented annually to a deserving member of the American Public Works Association in recognition of an outstanding and meritorious achievement in the broad field of sanitation—including refuse collection and disposal, street sanitation, sewers and sewage treatment, and water supply and treatment. It consists of an honorarium of \$500 and a scroll describing the achievement.

To be eligible, the candidate need not to have made a revolutionary invention, but to have simply done something which reveals originality of thought and aggressiveness of execution in the operation or administration of a function, or the design of a facility in his particular community.

The Award will be presented at the annual Public Works Congress and Equipment Show, August 14-17,

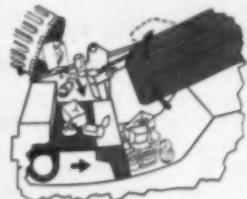
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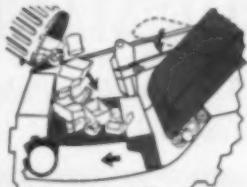
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in New York City. The candidate must be an active member of the Association, engaged in full-time employment with a municipal government. The recipient shall be selected by the awards committee and confirmed by the Association's Board of Directors.

Other members of the Nichols Award Committee are: Samuel Baxter, Commissioner, Water Department, Philadelphia, Pa.; and A. M. Rawn, Chairman, California State Water Pollution Control Board, Los Angeles, California.

APWA Forms Public Relations Committee

Chicago, Ill.—Rear Admiral Cushing Phillips, USN (Ret.) President, Board of Public Works, Los Angeles, Calif., has just been named by Jean L. Vincenz, President of the American Public Works Association, as chairman of APWA's newly formed public relations committee.

One of the main objectives of the Association's 1960 program will be to foster, through a public education program, a better understanding of the function of public works in a community and of the people working in this field, and to strengthen the professional status

of the public works engineer and administrator. Another aspect of the program will be to develop greater citizen support for public works projects and to attract competent personnel to the field.

Other members of the Association who have accepted appointment to serve on this committee are:

Hon. Ben West, Mayor, Nashville, Tenn.; Milton Rosen, Commissioner, Dept. of Public Utilities, St. Paul, Minn.; Paul R. Screvane, Commissioner, Dept. of Sanitation, New York City, N. Y.; Col. W. A. Hardenbergh, President, Public Works Publications, Ridgewood, N. J.; Stanley Palmer, City Engineer, Kansas City, Mo.; Roy Morse, Chairman, Board of Public Works, Seattle, Wash.; and James F. Steiner, Manager, Construction and Civic Development Department, U. S. Chamber of Commerce, Washington, D. C.

How County Road Design Affects Municipalities

Ames, Iowa—"County Road Design and How it affects Municipalities," one of the topics discussed at the recent APWA Iowa Chapter Meeting in Ames, Iowa, proved to be a subject of great interest.

The Conference, held March 16-17, was co-sponsored by the Iowa Chapter of the American Public Works Association and the Civil Engineering Department, Iowa State University.

The discussion on county road design centered chiefly around the differences between cross-sections of county roads and urban streets. The problem concerns the transition of rural roads to urban streets. Basically, to facilitate ditch drainage and snow removal, the grade line is high in the county road section, while the city street section has a low grade line to facilitate drainage to the street level and into the storm sewer system.

When a city expands its limits, the grade established by the county is not suitable for urban street construction. Thus benefits from county road improvements and their cost are lost if the area is annexed.

The conclusion of the panel was that in improving a county road in an area that may be annexed soon by a city, a cross-section should be used that most closely resembles the city's standards. This recommendation calls for more cooperation between the county engineer and the city engineer to determine such questions as: the direction in which

THE MANUFACTURER'S PLACE IN APWA

The American Public Works Association, founded in 1894, is a non-profit, public service organization dedicated to the promotion of improved practices in the broad field of public works.

The Association serves as a common meeting ground for some 5,000 public works engineers and administrators, and others engaged directly or indirectly in the public works field. Since the cost of building, operating, and maintaining highways, water supply and refuse and sewage disposal systems is greatly influenced by the types of equipment and materials used, the APWA has established a Sustaining Membership for manufacturers designed to give them an accurate picture of current trends and developments in



Headquarters Office of the
AMERICAN PUBLIC WORKS ASSOCIATION
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public works . . . and, thus, gain a better understanding of how they can best serve this vast and growing field. In this way the manufacturer can assist the Association in its efforts to acquaint public works officials with the possible economies offered by the use of new and improved products.

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1. Exhibit privileges at the Annual Congress and Equipment Show. (1960 Show—New York City, Aug. 14-17)
2. Free advertising privileges in the annual Yearbook . . . a discount on News Letter advertising.
3. An unusual opportunity for meeting public works officials and participating in Association and Chapter activities.

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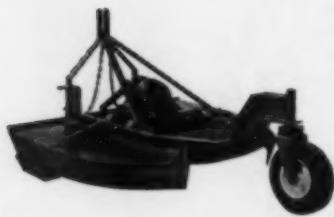


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the city might grow, its rate of growth and which roads might be affected. It was pointed out that the cooperation between the county and city engineer has already resulted in an improvement of these conditions in several Iowa counties, resulting in substantial savings to the taxpayers involved.

Paul Morgan, Associate Professor of Civil Engineering, Iowa State University, speaking on sewage and industrial wastes, pointed out that a statewide survey a few years ago revealed that some sewage plants in Iowa were found to be in very poor condition after only 10 years of operation. Others that had been operating for 35 to 40 years were performing almost as well as when they were new and in good physical condition. This was traceable in many instances to the plant operator and the manner in which he maintained and operated the equipment in his plant.

Because of these findings the Iowa Sewage and Industrial Wastes Association is promoting the training and certification of operators in the State of Iowa. In the western two-thirds of the state, Iowa State University holds training courses and in the eastern one-third of the state the University of Iowa holds similar courses. In 17 training courses held in the state, about 225 operators have completed their training and have been certified.

Other topics on the agenda for the two-day conference included: "Sewer Cleaning and Maintenance"; "What Can the Public Works Official Do to Promote Public Relations?"; "Drainage of Metropolitan Seattle"; "Standardization of Design and Specifications"; "Municipal Uses of Pre-cast and Pre-stress Concrete"; "Snow and Ice Removal"; and "Justification of a Municipal Budget and Operating Within Your Budget."

Mobile Feeding Stations



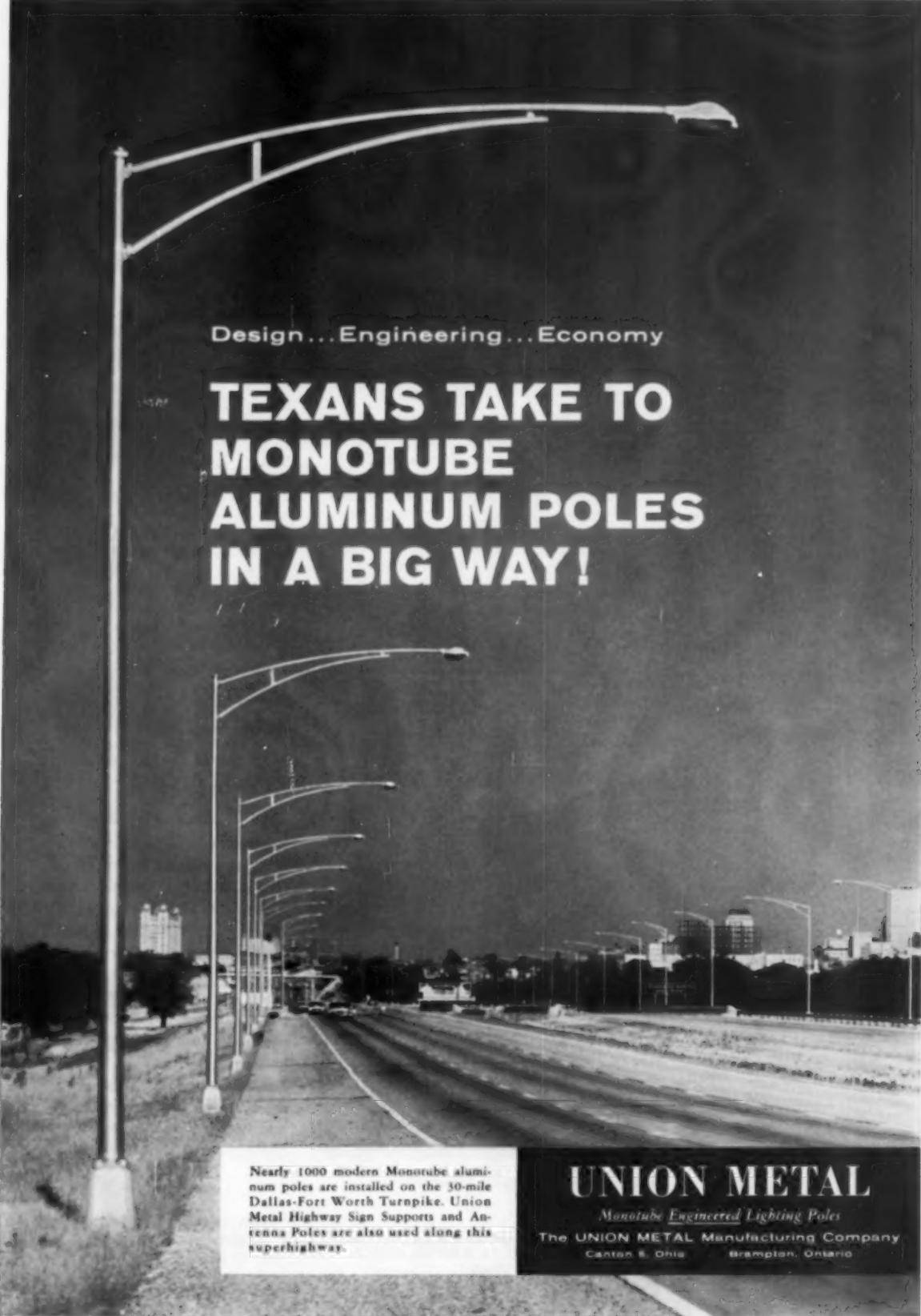
● EMERGENCY mass feeding vehicle developed for Maine Civil Defense Agency.

THESE mobile feeding units are fully equipped to prepare and serve hot food to large groups of people in the event of disaster. Working in cooperation with the State of Maine Civil Defense and Public Safety Department, which recently took delivery of seven units, the Boyertown Auto Body Works of Boyertown, Pa., developed and constructed them.

Built on 1½ ton forward control type chassis, there is installed an electric refrigerator, gas range, steam table, coffee urns, double stainless steel sink, 65-gallon water supply, counter work tops and storage cabinets. A portable gasoline

powered generator, stored inside, furnishes power for interior lights, floodlights, and refrigerator; or operation can be from an outside electric supply. The gas range, steam table, and coffee urns are operated by propane gas; a gasoline fired space heater provides heat. There are provisions for connection to an external water supply.

The hot food is served through the rear of the truck which opens to full width and is illuminated by floodlights. The work space is illuminated by fluorescent lighting and translucent roof panels. There are electrically operated ventilators installed in the roof of the vehicle.



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Report Analyzes Accidents of Municipal Employees

Reporting on the work of the City Personnel Safety Committee of Tallahassee, Fla., for the year ending Sept. 30, 1959, William F. Jacobs, Personnel Safety Officer, called attention to several interesting points in accident occurrence and reporting. During the year there were 183 accidents, varying from 6 to 32 per month. There appeared to be a positive seasonal peak in accidents beginning in June, reaching its maximum in July and receding in August. This is definitely attributed to the summer employment of "immature, unskilled and inexperienced high school and college students." Total man-days lost due to accidents totalled 380, representing 0.2 percent of total man-days worked. Extracts from the report follow.

Fundamental to any analysis of accident causes and their prevention is a study of the work done, the types of equipment employed, the occupation hazards involved and the organizing ability of the supervisors.

With some jobs, such as policing, fire fighting and electrical construc-

tion, where a group of men carry out the same assignments day in and day out, it was possible to survey the accident record on a departmental basis.

With some other groups, particularly public works crews, the men may be employed on a variety of jobs for varying periods, with appropriate equipment assigned to the particular task, a changing hazard picture—but with the same supervisory personnel. Under such conditions, safety and prevention of accidents must depend largely upon the foreman in charge.

Garbage-collecting activities produced the most accidents; a sewer construction crew was second; the electrical department third; police fourth; parks fifth; and the fire department sixth. All of these employed numerous men.

Evaluating the Record

However, these figures can serve only as a basis for evaluating the comparative safety record. Everything else being equal, a crew of 30

men would be expected to have twice as many accidents as a crew of 15 men doing the same kind of work with the same kind of tools. When vehicles, such as dump trucks, bulldozers or ditching machines are employed the accident rate will tend to increase and the increase should be proportional to the number of such machines employed.

Further, the hazards of the work must be taken into account. An electric crew working 8 hours a day with "hot" wires can be expected to have more accidents than a park crew working with lawn-mowers and leaf-rakes.

Industrial safety and insurance agencies must have developed, through their research, risk classifications and comparative figures which could be used to interpret the City's accident and related statistics. However, we have been unable to locate such information through sources available to us locally.

We have, therefore, adopted for this report certain arbitrary factors which we believe are reasonable assumptions—but are certainly subject to question and which might be completely discredited.

These assumptions are:

a. The basic safety rating of a crew may be established by the in-



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Materials handling and waste disposal are two of the few areas of large potential cost reduction remaining in manufacturing and municipal administration. This new catalog has a bearing on both of these areas of operation.

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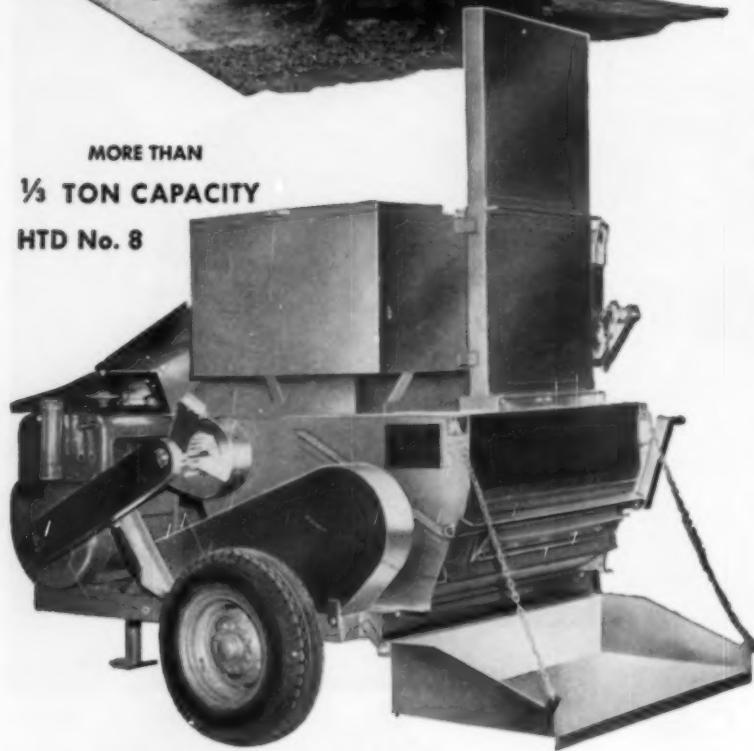
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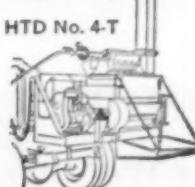
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verse proportions of accidents to the number of men normally comprising the crew. Example: One accident during the year in a 10-man crew would give the crew a safety rating of 90; 25 accidents in a 50-man crew would give it a rating of 50.

b. Vehicles or mobile equipment on the job increases accidents in proportion to the number of such machines. In order to arrive at an adjusted rating, the base rating is increased by a number equal to the number of machines employed by the crew. Example: if a crew has a base rating of 80 and uses regularly 13 machines or vehicles, its safety rating becomes 80 plus 13, or 93.

c. The effect of the occupational hazards is very positive but its determination is most controversial and more difficult to assume. For this report, the usual work of the crew has been classified from "A" through "F"—with "A" regarded as the most hazardous and "F" as the least so. No adjustment in the rating has been made for an "F" classification but a crew with an "E" classification is increased by two-tenths of its rating; a "C" by three-tenths; a "B" by four-tenths; and an "A" hazard crew's adjusted rating is increased by five-tenths to determine its final rating. Examples: A crew with an adjusted rating of 80 has a hazard classification of "C"; this will increase its rating by 0.3 times 80, or 24, and its final rating becomes 104.0. A crew with an adjusted rating of 75 has a hazard classification of "B"; this will increase its rating by 0.4 times 75, or 30, and its final safety rating is raised to 105.0. On this basis, final ratings ranged from a high of 132.7 to a low of 60.8.

Disability Costs

Costs growing out of personnel injuries are comprised of doctors' charges, miscellaneous medical costs, such as hospitalization and prescriptions, and workmen's compensation or wages paid to the injured parties during their disability. An analysis of these totals show: a) Average per incident: doctor, \$21.56; miscellaneous medical, \$8.29; compensation, \$31.94; a total of \$61.79 per case. b) Average per month: doctors, \$328.81; miscellaneous medical, \$126.40; compensation, \$487.16; a total of \$942.37 per month.

• • •

Plastic Pipeline Laid Across Lake

The idea of launching a half-mile of plastic pipe, wrapping strips of lead around it and sinking the whole works to the bottom of a lake,

saved the residents of Milton, Vermont, thousands of dollars and cut pipeline installation time from 20 days to 8 hours.

The plastic pipe, made by Republic Steel Corporation, was submerged recently to replace a line buried beneath seven fathoms of man-made lake. The water represented a 2,900-foot obstacle between eight Milton homes and the town's only water supply. The Milton Water Corporation decided to experiment with the flexible plastic pipe. Inasmuch as the lake is used for boating and swimming in summer and is often coated with more than three feet of ice in winter, the proposed pipeline had to hug the lake floor.

As supervisor of the Milton Water Corporation, Kenneth G. Miner put the plastic pipe on trial and spent almost a year developing a system of weights which would hold the pipe below the lake surface yet would not pinch or chafe the pipe exterior. Using 3-inch wide, $\frac{1}{8}$ -inch thick lead sheeting strips and spacing them between eight and twelve feet apart, the pipe was kept submerged.

To install the pipe, a crew of six was required. Lengths of Republic's 100 pound FE, 1 $\frac{1}{2}$ -in. polyethylene pipe were joined by metal couplings and clamps. Then the snake-like 3500-ft. line was laid along the shore in loops, ribbon candy fashion. Both ends of the line were sealed with plugs and the pipeline "to be" was set afloat on the water. Being lightweight and airtight, the pipe floated on the lake surface and was easily towed into position. Workmen connected one end of the pipe to a line leading to a pump station, towed the other end to the opposite shore and connected it to the house service lines.

The pipe was then filled with water. It sank—but only to a level just below the surface. From a boat the crew wrapped the lead strips once around the pipe at the specified intervals. At the end of one eight-hour day the job was complete and the new water line rested 40 feet below the surface, following the contour of the lake bottom.

Sewage Treatment Plant Operating Data

During 1958, the sewage flow in Ithaca, N. Y., averaged 129.36 gpcd and the cost of treatment was \$33.43 per MG. Per million gallons of sewage, screenings amounted to 3.40 cu. ft.; sludge 497 cu. ft.; and gas produced 3,401 cu. ft.

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No machine is better than its engine—and the new Cat Diesel Engines in these three new series Motor Graders are better than ever. They're more compact, more rugged and modern in design. They incorporate the latest developments in metallurgy and technology. They provide three important bonuses—greater lugging ability in tough going, easier servicing and long life.

A COMPLETE LINE—85 HP to 150 HP

The new Turbocharged 100 HP No. 112F is designed for high production to match work requirements between the new 85 HP No. 112E and new 115 HP No. 12E. Compared with the 85 HP model, the 100 HP machine delivers 5% higher travel speeds and a 5% increase in blade speed control. With its introduction into the line, Caterpillar now offers you a choice of four Motor Graders in all to meet your specific requirements. The largest is the Turbocharged 150 HP No. 14, the most versatile big grader ever developed.

SEE YOUR CATERPILLAR DEALER

Some of the features of the new Cat Motor Graders are described briefly here. But for the complete picture, see your Caterpillar Dealer. Ask him to show you how they're a better investment for your tax dollars than ever. Take a look under the hoods at the new modern-design engines. Better still, ask for a demonstration. See for yourself how they "pull through" tough going.

Caterpillar Tractor Co., General Offices, Peoria, Ill.

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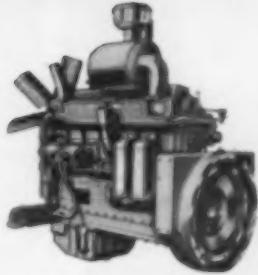
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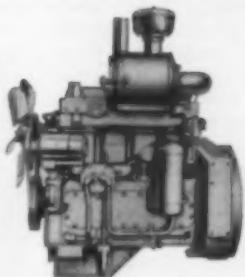
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New No. 12E Motor Grader
features new compact
115 HP Engine



New No. 112E Motor Grader
features new compact
85 HP Engine



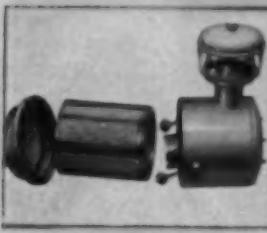
NEW HIGH TORQUE. Though the engines in the new Cat Motor Graders are designed specifically for each machine, they all develop higher torque than previous models and have other basic improvements in common. For example: shorter, stiffer blocks and crankshafts...stronger, distortion-resistant cylinder heads...improved cooling systems with greater capacity...engine lubricating oil conditioning...and advanced design fuel systems

—new, compact fuel injection pumps with barrel and plunger assemblies in easy-to-service pump housings.

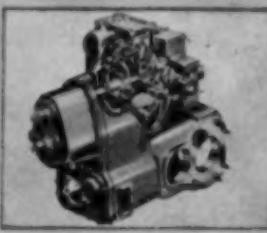
NEW STARTING ENGINE. Now standard is a new two-cylinder, vertical starting engine to replace the horizontal engine. All three Motor Graders use a modern 12-volt electric system. An optional 24-volt system is available for use in moderate climates where direct electric starting is practical.

PERFORMANCE-PROVED FEATURES. While many advances have been designed into the compact new engines, certain time-tested features have been retained. To mention a few: precombustion chamber design that delivers maximum horsepower on heavy, economy-type fuels...steel-back aluminum bearings...wet-type "Hi-Electro" hardened cylinder liners...and aluminum pistons with cast-in ring band.

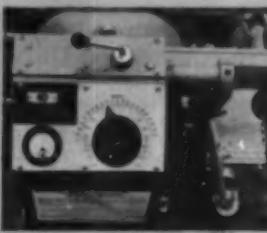
OTHER HIGH-PRODUCTION FEATURES IN CAT MOTOR GRADERS



NEW DRY-TYPE AIR CLEANER (standard) removes a minimum of 99.8% of all dirt from intake air during every service hour. Can be serviced in 5 minutes. Cuts your maintenance time by as much as 70% and substantially reduces maintenance costs. Cleaner air also extends engine life.



EXCLUSIVE OIL CLUTCH (standard) provides up to 2000 hours service without adjustment, the equivalent of about 12 months of "adjustment-free" operation. A Caterpillar development proved by millions of hours of use, it virtually eliminates down time for clutch repair.



AUTOMATIC BLADE CONTROL (optional) cuts grading time in half. Operator sets desired slope on dial and only has to control depth of cut. Manufactured by Preco Incorporated, the unit automatically maintains blade slope within $\frac{1}{8}$ " in 10'. Available factory installed.



IN-SEAT STARTING (standard) offers operator finger-tip convenience and positive starts in any weather. Another feature: improved mechanical blade controls provide precise adjustment and ease of engagement. "Anti-creep" lock makes blade stay put under load.

THE
HIGHWAY
AND
AIRPORT
DIGEST



Prepared by L. G. BYRD, Associate Editor

**Pumping Expressway
Storm Water**

The design of the Prospect Expressway in the Borough of Brooklyn, City of New York included special provisions for storm drainage since the Expressway is approximately 12 feet below the elevation of the existing storm sewers in the area. The Expressway is drained into a wet well and the storm water pumped into the city sewer system. Runoff computations to determine pumping station requirements were based on a rainfall intensity of 5.5 inches. This corresponds to a rate of 1.75 inches per hour and a time of concentration of 8.4 minutes for a 15-year maximum storm. The area to be drained was 6 acres, the coefficient of imperviousness 0.90 and the design rate of runoff 13,000 gallons per minute. Two pumps, capable of delivering 65,000 gpm against a 35-ft. dynamic head, were installed to provide for the required design runoff with a third identical pump as a standby in case of mechanical failure. A 17' 7 1/2" wide by 38' 6" long pump house was designed around these three pumps and a wet well. The roof of the structure carries vehicular traffic of the surface-level service road and the outside wall conforms to the appearance of the adjoining retaining walls and bridge abutment. The interior of the heated, lighted and ventilated building is subdivided into three cells. Two lower cells serve as the wet well, the bottom of which is 12 feet below the lowest point of the Expressway. A grit chamber with cleaning arrangements for chamber and well are provided. Main pump impellers with housings and 16-in. pump columns are located in the wet well. Discharge heads located on a concrete floor 24-ft. above the wet well connect through 16-in. pipes with a stilling chamber from which water is carried through a 36-in.

monolithic concrete sewer pipe to the original 60-in. sewer line.

"Storm Water Pumping for an Urban Expressway." By Frank J. Buckley, Shumavon & Buckley, Consulting Engineers, New York. PUBLIC WORKS, April, 1960.

**Asphalt Quality
Control Research**

"Consistency of Asphalt," is the first part in a series of five articles on research studies aimed at developing ways of improving quality of asphalt paving. That property of asphalt which offers resistance to deformation—both viscous and elastic—by an applied force is called its consistency. Elastic deformation will eventually disappear after the applied force is removed, where viscous deformation is not recoverable. Since the life of a bituminous pavement will depend to a great extent

upon the consistency of the asphalt at any given temperature, and since the viscous element of consistency is of great importance, the viscosity-temperature coefficient must be maintained as low as possible in road-building asphalts. This characteristic is commonly called a low temperature susceptibility. The development of the Engler, Redwood, Barbey and Saybolt viscosimeters served to evaluate and control asphaltic materials at manufacturing and handling temperatures. The penetrometer was then designed to evaluate asphalt consistency at atmospheric temperatures. As asphalt technology developed it became apparent that the penetration test was inadequate to reveal and evaluate those fundamental properties of asphalt attributed to viscosity. The development of absolute viscometers has now permitted the evalua-

Grade Separation Clearance Increased to 16 Feet



● RAISING partly completed deck of grade separation on Interstate 94 near Jackson, Mich. to provide 16-ft. clearance required by Bureau of Public Roads. To allow for future resurfacing and for snow pack, actual clearance of 16 ft. 3 ins. is provided.



Flood rescue proves Michigan ability to operate in deep water

This picture was taken during one of the worst floods in the history of Canton, Ohio!

The machine shown is a *Tractor Shovel*—one of three city-owned Michigans that joined ordinary boats and rafts to speed rescue work.

Despite muck and silt and the 5 foot depth of the raging waters, the Michigans plowed along without pause, moving hundreds of people to higher ground. Their use, unplanned, nonetheless proves *Michigans can work successfully in deep water* no matter what the task—flood rescue, stream crossings, beach cleaning, etc., etc.

Switch from roadbuilding to diking to "ferry service"

It all started when heavy spring thaws released a torrent of water into Nimishilien Creek. The water rose—and rose—soon over-ran its banks, and poured out over a 25-block area of Canton's north-

east side. Call went out to the three 14 and 1½ yd Michigans. In they rushed from normal roadbuilding and material-handling chores, started building retaining walls. Soon, though, it became obvious the water was rising so rapidly dikes weren't nearly as important as saving people. Nobody thought *any vehicle* could get through, but the need was so great the Michigans were tried.

They did the job!

First, the very old and the very young, the crippled, the bed-ridden were scooped from danger and carried away in the machines' big (6'7" and 7'1" wide) buckets. When the infirm were safe, the Michigans ferried out load after load of healthy evacuees.

"These machines certainly saved the day for us," said Wilson J. Myers, Service Director for the City of Canton. "They plowed through the shoulder-high water like steel whales with a mouthful of Jonahs. They even put the boats to

shame. The Michigans were faster and they didn't tip in the current."

In water several days, yet no repairs needed

Wilbur Schultz, Canton's vehicle maintenance superintendent, pointed out that Michigans worked round-the-clock at the flood scene with only an occasional rest—and that only for refueling.

"These rigs did a wonderful amphibious job for us and didn't require any major over-haul despite their prolonged bath," said Mr. Schultz. "They were nearly submerged for hours at a time; yet, after the flood threat ended, we only had to drain, clean out and recharge the oil in the differential housings."

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easy on your budget, too!

Only TRAFFICAIDE's quick-setting mastic is needed for secure bonding to any pavement. Markers dry into place immediately. Traffic flows freely, releasing traffic control personnel for productive work. But the greatest saving of all is the extremely low maintenance cost that keeps your traffic marking system at peak efficiency throughout the years ahead. TRAFFICAIDE markings include directional arrows; crosswalks; square—rectangular and diamond shapes; lane—berm and no passing lines; parking or car limits; letters, words and numerals.

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Long Life Specialized Pavement
Markers with general specifications.

tion of materials possessing a wide range of consistency. One of the modern types, the microfilm viscometer, employs a uniform film of asphalt about 25 microns (1/1000-in.) thick placed between two glass plates measuring 3 by 2 cm. The exact thickness of the asphalt film is determined from its weight and surface area. The plates are inserted in the viscometer where one is held stationary while the other is moved by application of a weight. The plate movement for a given period of time is recorded. The viscosity is then calculated from the weight applied and rate of movement. Another complication of consistency and flow properties of asphalt successfully evaluated through the use of the viscometer is the presence of internal structure in the asphalt which results in complex flow. The increasing use of the viscometer will make possible further advancing of bituminous technology.

"Research in Asphalt Quality Control." By Dr. R. N. Traxler, Research Engineer, Texas Transportation Institute, *Texas Highways*, March, 1960.

City Forces Resurface Streets

The expenditure of \$50,000 in one year for patching and sealing Marinette, Wisconsin streets convinced the city administration that it was time to study the entire street problem. Studies showed that the most economical solution would be to resurface the concrete pavements and the macadam surfaces on a good base with a plant-mix asphalt and to use a soil-cement base on new construction. The procurement of asphaltic concrete from the nearest source—some 60 miles away—was estimated at \$7.50 at the plant plus 4 cents a ton-mile for hauling. Laying costs were estimated at \$2.50 per ton. The alternative of contracting for the work was eliminated due to the volume of work which would be required to interest bidders. The choice of doing the work with municipally-owned equipment was finally selected. A 20-ton per hour Hetherington-Berner batch-type asphalt plant, a used Barber-Greene paver and a used 8 to 10-ton Galion roller were purchased. Material analyses and proportioning recommendations were made by the Wisconsin Highway Commission. Plant operation was started in 1958 and city forces laid approximately 4000 tons of asphaltic concrete that year. Production costs averaged \$5.02 per ton and laying costs were \$2.45 per ton. During



BATON ROUGE, LOUISIANA—Two Huber-Warco 6-D2 motor graders are used by the Baton Rouge Department of Public Works to help maintain gravel streets, cut ditches and construction of new pavement. One is assigned to the Urban Division and the other to the Rural Division.



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POWER SHIFT TRANSMISSION—Power shifting makes the grader far easier to operate because of fewer controls. Shifting up or down under load at full throttle is done by moving one lever. Tailshaft governor maintains speed set on hand throttle.

HYDRAULIC CONTROLS—Complete blade control without leaving the cab—including all bank sloping positions. Easiest graders to operate means less operator fatigue and more production.

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Standard transmission models from 83 to 160 H.P.
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3-5 Ton • 4-6 Ton
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3-WHEEL ROLLERS

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HUBER-WARCO COMPANY

Marion, Ohio, U.S.A.

1959, 6,055 tons were placed at \$4.57 production and \$2.06 laying costs per ton. All costs are complete, including fringe benefits on labor charges and maintenance, depreciation, insurance and storage of equipment. A typical work program includes: Preparing the foundation where the material is to be laid; shaping and stabilization of the base; emulsion prime coating of the base; placement of a "wedge course" on new surface work; and laying the asphalt mix in two courses.

"Why We Do Our Own Paving."
By Robert J. Poss, City Engineer, Marinette, Wisconsin. *The American City*, March, 1960.

Snow Fighting on Parkway

Under Ross Vogt, Superintendent of Maintenance on the Garden State Parkway, maintenance forces are divided into ten districts along the 174-mile super highway. The road follows a route that subjects it to unusual and widely varying weather and traffic conditions. The northern stretches are subjected to heavy snows while the pine barrens along the lower Jersey coast are buffeted with ocean winds and freezing rains. Where the Parkway passes close to

New York City and Newark, heavy traffic must be kept moving. A typical maintenance district stockpiles a 900-ton salt supply along with calcium chloride and sand.

"Snow Fighting on Parkway Can Be Unpredictable." *Constructioneer*, March 14, 1960.

Highway Department Engineering Costs

In December of 1959 each of the 50 state highway departments and the District of Columbia were asked by correspondence for comparative cost figures for engineering work on interstate highways when done by employee engineers of the state highway departments. In order that a uniform comparison could be made, each letter referred to Technical Bulletin No. 245, "A Reference Guide for Negotiation of Engineering Services for Highway Work," as prepared by The Committee on Professional Engineering Services of the Engineering Division of the American Road Builders' Association. It was recognized when these letters were written that a 100 percent reply was unlikely. It was felt however that these letters would remind highway departments of the need for comparative figures

and the answers received would show consulting engineers the attitudes of state highway departments and how the departments made their cost comparisons. The replies received from the 26 responding states indicated that employee engineering cost data is not readily available from highway department accounting records.

"Engineering Costs in State Highway Departments." *Consulting Engineer*, March, 1960.

Turnpike Culverts Inspected

Inspection of the 20-year-old corrugated metal culverts on the Pennsylvania Turnpike was completed in 1959 by Armeo Drainage engineers. The inspection included photographing each structure and making a detailed report on the following: Location; diameter; length; estimated fill height; type of terrain drained; alignment and deflection; pH of the water; condition of bituminous coating and paving; and formation of rust on exposed metal. Forty-seven pipe structures were examined representing sizes from 24 to 72 in. in diameter and lengths from 92 to 540 ft. Structurally, nearly all were in good condition; only

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PUBLIC WORKS for May, 1960

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FOR MIXED BRUSH—**LINE RIDER LV-3D/3T**, a 2-Ethyl Hexyl Ester formulation of 2,4-D and 2,4,5-T containing 3 pounds each of acid equivalent per gallon.

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Send for new brochure giving details. Diamond Alkali Company, Union Commerce Bldg., Cleveland 14, Ohio.

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one was found with a non-progressive deflection of 5 percent. The corrugated metal pipes, the product of four different manufacturers, were all bituminous coated and paved. Coating and paving condition varied from severe cracking and flaking with large chunks or sections missing, to coatings in good condition with little deterioration and bituminous material still sticky to the touch. Coating conditions were related in part to the method of manufacture or the field installation procedures. Conclusions drawn from the inspections were that the culverts were performing well

structurally under normal to fairly severe loading and foundation conditions.

"Penn Turnpike Culverts Get Inspection OK." By R. W. Rankin, Drainage Engineer, Armco Drainage & Metal Products, Inc. *Roads and Streets*, March, 1960.

Roadway Lighting Developments

Safe, comfortable night driving is the desire of many drivers, merchants and engineers: For social and recreational contacts; to save daylight hours for activities other

than travel; to complete necessary travel for work or shopping; for extension of good retail business hours; to improve night capacity and safety of roadways; and to generate compensating tax revenues for financing highway improvements. New developments which are discussed in detail include: More efficient and effective products; improved roadway lighting practices; lighting effectiveness ratings; and instrumentation for field measurement of seeing factors.

"New Developments in the Field of Roadway Lighting." By Charles H. Rex, Roadway Lighting Advance Development Engineer, General Electric Company. *Traffic Engineering*, March, 1960.

Principles of Soils Engineering

The third and final part of this series of articles deals with construction applications of previously developed principles. Special problems dealing with excavation are most often related to cave-ins in trenches and other structural foundation cuts. Such problems arise due to shear failure in the soil. A form of analysis similar to that for slope stability is suggested. A major soil problem with embankments is settlement. Prediction of settlements being difficult, designers often tend toward excessive compaction requirements without adequate analysis of the desired influence of compaction on stability or settlement. In evaluating methods of compaction two criteria are needed: Adequacy of final density and uniformity of density in the embankment section. The value of compaction of the subgrade and the importance of such compaction to the pavement performance are emphasized. Special problems discussed include: Soft ground (such as organic silts and clays); landslides; sewer construction; and stabilization.

"Principles of Soils Engineering." By Robert F. Baker, Professor of Civil Engineering, The Ohio State University. *PUBLIC WORKS*, April, 1960.

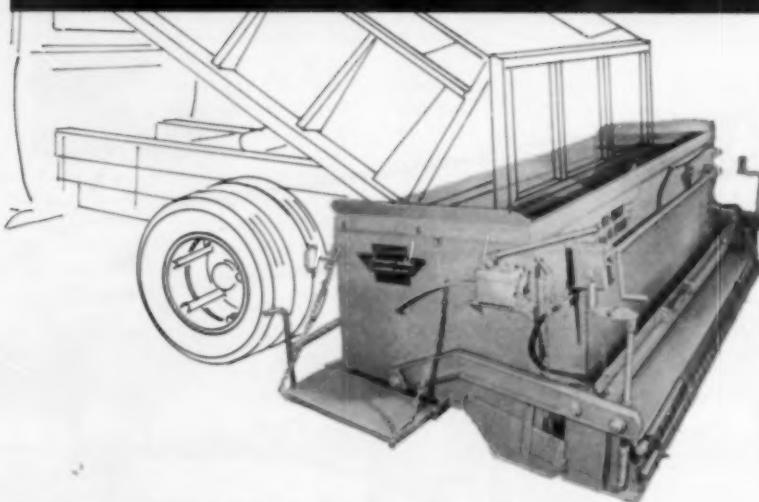
Other Articles

"How to Alleviate Winter Salt Corrosion on Trucks." Protection of trucks from snow and ice control chemicals by inauguration of a good maintenance program can add years of usable life to the vehicles. By Rolland L. Jerry, Editor, *Motor Truck and Coach. Roads and Engineering Construction*, March, 1960.

"Where States Stand on Central and

PUBLIC WORKS for May, 1960

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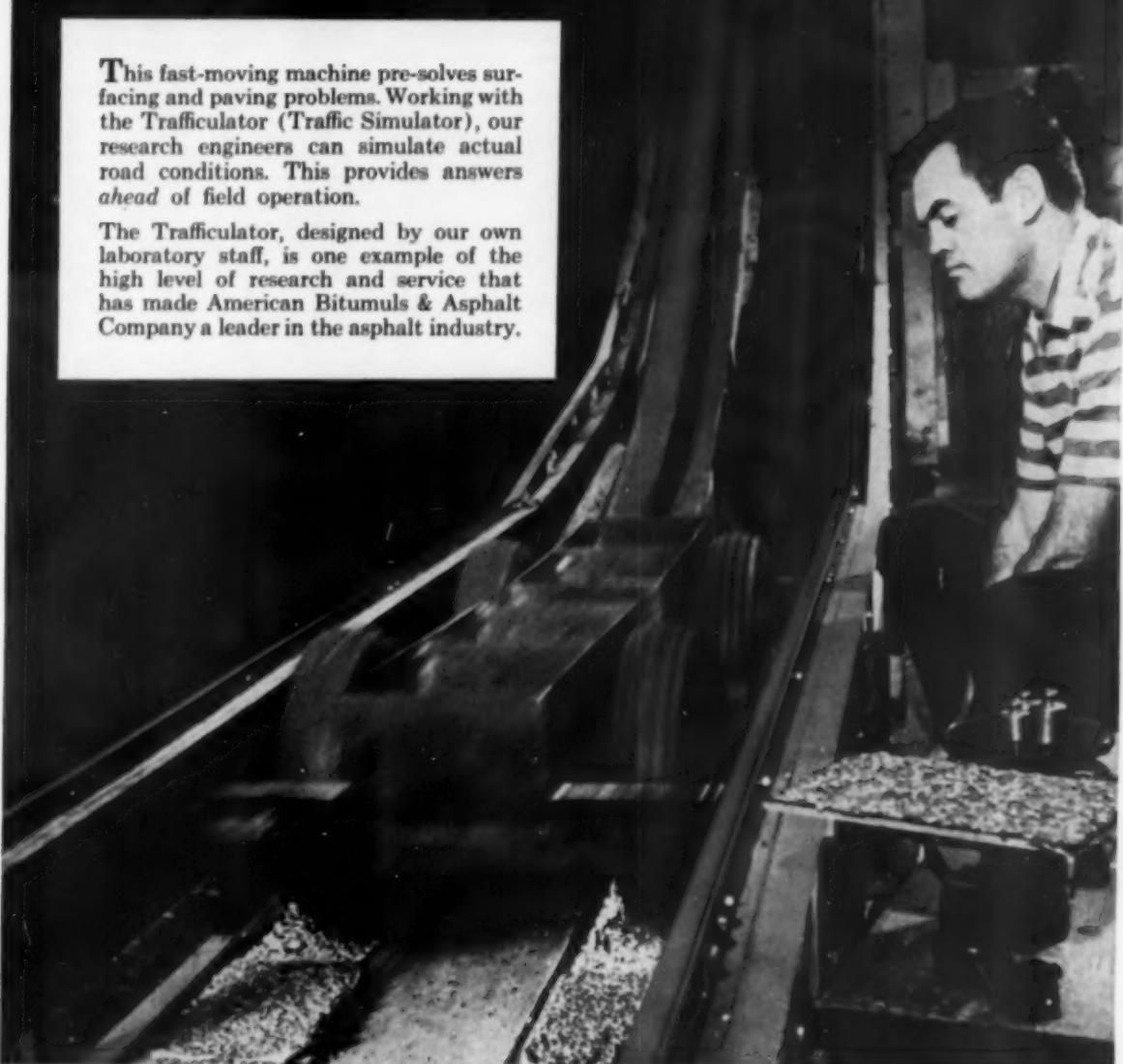
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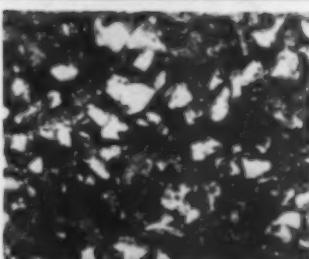
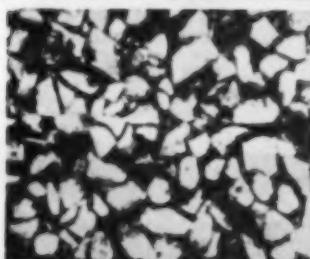
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After 1,000 passes by the Trafficulator, cover stone retention on the Cationic panel (left) is 70% better (by weight) than on the panel prepared with regular grade emulsion.

Transit Mix. Many departments still limit its use in highway paving, latest survey reveals. Roads and Streets, March, 1960.

Compaction Results With the Heavy Self-Propelled Rubber-Tired Roller. By A. O. Williamson, Manager, Bros Inc. Roads and Streets, March, 1960.

Pedestrian-Vehicular Separation in Downtown Chicago. A report on a panel discussion held at the general meeting of the Western Society of Engineers on October 27, 1959. Midwest Engineer, March, 1960.

Highway House Organs Help Employee Morale. At least 28 state highway departments publish a magazine or newspaper-type publication regularly. Not all are for employees only, but all help to weld employees together and to keep them informed. Better Roads, March, 1960.

Blueprint for County Highways. Highway study for Hennepin County, Minnesota, was authorized when it became apparent that suburban growth would accelerate during coming years. Better Roads, March, 1960.

Hiring Consultants. How municipal officials can best determine the need for outside consulting services and the factors to be considered in obtaining such services. By Fred Weisbrod, former City Manager, Painesville, Ohio. Ohio Cities and Villages, March, 1960.

Whither Street Lighting. Important recent developments may introduce a

new era in lighting design in Great Britain. Highway and Bridges and Engineering Works, March 9th, 1960.

Time-Lapse Movie Photography Used to Study Traffic Flow Characteristics. By Donald O. Covault, Associate Professor of Civil Engineering, Georgia Institute of Technology. Traffic Engineering, March, 1960.

The Density Factor in Traffic Flow. The significance of density as a basic element of traffic flow is discussed. By Bruce D. Greenshields, Assistant Director, Transportation Institute, The University of Michigan. Traffic Engineering, March, 1960.

Criteria for Off-Street Parking. San Francisco engineers devised a template-type of analysis for quick and uniform evaluation of off-street parking areas. By William Marconi, Assistant City Traffic Engineer, San Francisco, California. PUBLIC WORKS, April, 1960.

Modernizing San Rafael's Street Lighting. Downtown and residential area lighting modernization wins public approval. By Norris M. Rawles, Supervisor of Public Works, San Rafael, California. PUBLIC WORKS, April, 1960.

Drainage Structures on the Alaska Highway. A review of the condition of bridges and culverts after 16 years' exposure to permafrost and muskeg foundation materials. By W. H. Spindler, Editor, Technical Publications, Armcro Drainage & Metal Products, Inc. PUBLIC WORKS, April, 1960.

Charlotte, N. C., Acquires Rapid Striping Machine

Faced with the responsibility of marking roads and streets of newly annexed suburban sections that nearly double the City's area, Charlotte, N. C., has purchased a Wald Town and County striping machine, the first to be placed into service in North Carolina. The new "push-button" machine would be used to apply approximately 80 percent of the 500 to 600 miles of markings that will be placed in 1960.

Expansion of the City's area made it necessary to obtain a striping machine that could move without delay from one location to another. The unit also stripes at 12 to 15 mph. Charlotte's street marking program has grown from 9.1 miles of streets marked in 1950 to 170 miles of streets and upwards of 600 miles of lines this year. Engineered specifically to the City's requirements, the machine is equipped with two 30-gallon tanks for white and yellow paint and a tank for 500 pounds of glass spheres. Spray guns are mounted on the left side of the chassis and can be readily moved to the right side. A built-in cleaning system flushes the guns after each use.

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TOP PHOTO: Location: Rath Park, Franklin Square, L. I., N. Y.
Architect: Herbert D. Phillips
Consulting Engineers: Barstow, Mulligan & Vollmer

LOWER PHOTO: Location: Fairleigh Dickinson University, Madison, N. J.
Electrical Consultant: R. L. Sykes

modern lighting at a realistic cost

Here are two contemporary outdoor lighting installations — one an all new municipal swimming pool and recreational area — the other, a prominent New Jersey University. Both chose the P&K all aluminum CIRCLElux lighting package to illuminate and compliment their roadways, walkways, landscape and architecture.

The sweeping lines of the P&K CIRCLElux davit blend with the modern one story architecture of the Rath Park Swimming Pool. Yet, the modern, but stately, design of the P&K CIRCLElux post is in good taste with the traditional architecture of Fairleigh Dickinson University. The CIRCLElux lighting package is the correct low level lighting choice to compliment almost all types of architecture.

The P&K CIRCLElux is available in a wide range of davit styles and mounting heights. The post is available in one basic design but at various mounting heights and with the CIRCLElux you have a choice of three light sources — incandescent, mercury vapor and fluorescent. This combination of luminaires and davits or posts will enable you to specify "packaged" lighting units. This means easier specifying by using matched components which in turn can customize your lighting projects. Send in your reservation now for the new CIRCLElux catalog.



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Determining Air Entrainment in Concrete

HERE IS ever increasing interest in air entrained concrete. Contractors, engineers, architects, testing laboratories, research groups and other agencies are requiring the proper control of admixtures to concrete mixes to obtain high quality air entrained concrete.

A vital function in quality control is the use of air entrainment meters to determine the amount of air entrained in the concrete. This series of photographs, prepared by Soiltest, Inc., illustrate the simple manner in which the test is conducted.

1. Concrete is poured into the $\frac{1}{4}$ -cubic-foot container. When it is $\frac{1}{2}$ filled, the contents are tamped 25 times to assure equal distribution. Tamping is repeated when $\frac{3}{4}$ full and when full.

2. Excess material is removed to assure an accurate $\frac{1}{4}$ -cubic-foot sample. Lip of material container is wiped clean.



ILLUSTRATIONS show how an air entrainment meter is used to determine the amount of air entrained in a sample of concrete. Text gives details of the method.

3. To determine the amount of entrained air in the sample, air is pumped into the receptacle and the percent of entrained air is read directly from the dial gauge.

4. A nomograph supplied with this meter permits determination of the specific gravity, SSD, and the percent of free moisture by weight of the test sample.

Danco ROTARY MOWER

Mow with Danco OTHER STATES DO

Danco Mowers are now in service in over 30 states, in Hawaii and Canada and in federal agencies such as the AEC, military branches and park services.

Heavy-duty rotary mowers designed especially for mowing weeds, grass and brush along highway right-of-way, or for mowing parks, airports, other large grass areas.

MODEL HR-8-I — Cuts full 96" width, will clear up to 30 miles of normal right-of-way per day.

MODEL HR-1 — Center-mount model cuts full 66" width, will clear up to 20 miles of normal right-of-way per day.

MODEL TDW — Trail type mower cuts full 60" width. With adjustable wheels, safety chains and safety shields, adjustable cutting height from 1" to 15". Has rugged 5/16" side frame.

Danco Rotary Mowers are available for use with most popular-make tractors. Write for descriptive literature.



Danco Center-Mount Model HR-8-I Mounted on IH Farmall 460.



Danco Center-Mount Model HR-1 Mounted on IH Farmall 340.



Danco Trail-Type Model TDW for std. drawbar, also available 3 pt. hitch.

Danuser

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TULSA, OKLAHOMA

PUBLIC WORKS for May, 1960

OWNERS HEAP PRAISE ON CHEVY'S HIGH-PERFORMANCE POWER!



"IDEAL TRUCK FOR THE MOUNTAINS"—TORSION-SPRING CHEVY WITH WORKMASTER SPECIAL V8!

Bill Bridges will tell you. He's a driver for Farmers Hardware, Athens, Ga. He's behind the wheel of that V8-powered LCF 6 days a week, 200 miles a day, with a lot of it low-gear mountain-country driving. "You could drive this one even if you've never driven a truck before," Bill Bridges says. "Handles just as well loaded as empty . . . takes curves like a passenger car and it's got plenty of power for long, hard pulls up steep mountain grades." Mr. Douglas Meyer, president of the company, praises his Chevy's 8-9 mpg economy, calls it "remarkable" on a route like this one.

■ The Workmaster Special VS's secret of success is nothing less than a super-efficient combination of high performance, gas-saving economy and high-mileage durability. Wedge-head combustion chambers are fully machined for smooth high compression (7.75 to 1), with short-stroke action pouring out a high 185 h.p. Owners talk about the performance of this engine, astonished at the way it handles big-tonnage loads. The next moment they're talking about its dependability, the way it keeps humming

along on a low minimum of maintenance. Drop in on your dealer and check his engine specs in detail. Ask about the new Powermatic transmission, too. Talk engine, models, capacities, everything. Just be sure to save some time for a trial run in a '60 Chevy. You'll see it's like no truck you've ever driven before. You'll also see why so many Chevy truck operators are able to get more work done in a day. Make it soon. . . . Chevrolet Division of General Motors, Detroit 2, Michigan.

1960 CHEVROLET STURDI-BILT TRUCKS



Rotary Mower Developments Make Roadside Maintenance Easier

NEWER highway systems have wider rights-of-way and much more grass area to be cut. Litter-bugging has increased and this presents an additional mowing problem, due to the presence of bottles and cans. The Danuser heavy duty rotary mower, which can be mounted amidships under a conventional high



● DANCO 66-in. center mounted rotary mows highway right-of-way without hazard from debris along the roadside.

clearance tractor, was developed to overcome these difficulties. It is available in sizes from 42-in. to 8-ft. It provides safety for the operator through full vision—no need to look to the rear to inspect cutting operation—and through a low center of gravity. It also safeguards traffic against flying objects by the use of a chain curtain. Blades are reversible, giving double life; and the large unit will handle trees to 4 ins. in diameter; and, of course, cuts and shreds weeds and bushes. Some 30 state highway departments are now using Danco rotaries.

• • •

Widener Facilitates Shoulder Construction

CAPABLE of building shoulders at a rate of 200 tons per hour, this Blaw-Knox widener placed stone to a total compacted depth of 4 inches on Route 16 near West Seneca, New York. Shoulders on each side of the 28-foot wide, 3½-mile long stretch now measure 5 feet in width.

Specifications of the New York State Department of Public Works called for shoulder areas to be graded and sprayed with emulsified asphalt. The widener placed 3A stone which was compacted with a 10-ton roller. Emulsified asphalt was placed, followed by No. 1 stone, and additional compaction. The widener's tandem drive wheels provided ample power for pushing the 20-ton capacity supply trucks.



● THIS Blaw Knox road widener is shown at work on a shoulder stabilization project near W. Seneca, N. Y.

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Model S-23
9 h.p. \$475. list

ly known farm tractors—at half the price! Look at these features: • Briggs & Stratton 9 h.p. engine • 2 power ranges • 1/4 to 10 m.p.h. Geared reduction steering wheel • 7" x 16" tires • Easy-lift tool lever • TIMKEN bearing transmission • Wide selection of "UNIT-DESIGN" tools, all priced below average costs • Unusual stability and rugged construction.

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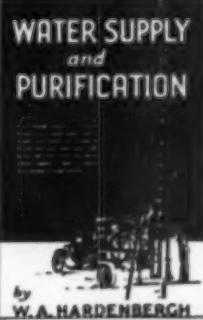
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Among the major changes introduced in this latest edition are the following: the chapters on ground water, on filtration, and on laying pipe and maintenance lines have been almost completely rewritten; the chapters on pipe conduits and on disinfection have been revised to bring the material in them up to date and a new chapter has been added on fluoridation.

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"Our improved control with POZZOLITH cuts costs on the Eglin Air Force Base job"

W. J. NOONAN, SR.,
President, Noonan Construction Co.,
Pensacola, Florida



DRY-BATCH PLANT located on the Gulf—approximately 9 miles from the job site. Most aggregates were delivered by barge from Radcliffe Gravel Co., Inc. of Mobile, Alabama. Ideal Cement was also transported to the batch plant by this method.

THIS CONTRACT at Eglin Air Force Base involved the placing of 110,000 cubic yards of unreinforced concrete. Pavement ranged from 14" to 22" thickness. Supervising the job is W. J. Noonan, Jr., General Manager, Noonan Construction Co. • Curtis Sullens, Concrete Supervisor, Corps of Engineers, Mobile District • John Day, Project Superintendent, Noonan Construction Co.

"Corps of Engineers specifications called for 650 psi flexural strength with 4 1/4% \pm 1 1/4% entrained air. We knew that with local materials and good control, a plain mix with a cement factor of about 6 sacks per cubic yard should produce this strength.

"We also knew that with POZZOLITH we could meet this flexural specification with 5 to 5.2 sacks and that POZZOLITH would provide close control of entrained air, as well as lower finishing costs. So we based our bid on using POZZOLITH.

"The job was started with a POZZOLITH mix having a cement factor of 5.8 sacks. Because of uniform strength results, well above specification, it was gradually reduced to the 5.2 sack factor which we used in our original estimates. The uniformity in batches, absence of bleeding, and exceptionally good workability kept finishing costs down. Air content was easily maintained at 3 1/4% with minor adjustments being made quickly in the field.

"The Master Builders field man worked with us from start to finish giving us the benefit of his experience. This resulted in better quality concrete at lower cost to the owner and substantial savings to us."

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• **RESEARCH PROJECT** aimed at the improvement of highway riding characteristics is being conducted by the Maryland State Roads Commission. In this study a uni-cycle type road roughness indicator is towed behind a panel truck. Vertical movement of the wheel is recorded on sensitive gauges and registered in the towing vehicle. Tests will be made on roads of various age, design and pavement surface.

Neoprene-Modified Asphalt for Turnpike Maintenance

Neoprene-modified asphalt is being specified for construction and maintenance of inside shoulders on the New Jersey Turnpike, according to Harold W. Goldberger, P.E., Engineer of Maintenance for the Turnpike Authority. Two installations totaling 13 miles in each direction have been completed between Newark and the northern terminus of the turnpike near the George Washington Bridge.

Neoprene has been used previously with asphalt emulsion to fill longitudinal cracks in the bituminous concrete pavement. Other uses of neoprene with various types of asphalt include the sealing of joints in sections of concrete pavement and bridge decks, sealing under-bridge slope protection pavement, and experimental surface treatments on the bituminous concrete roadways to improve anti-skid qualities.

The prime objectives in adding 1½ percent neoprene to the asphalt used on the shoulders were workability, chip retention, and elasticity. These properties reduce bleed-through, improve traction, and give better performance at high summer and low winter temperatures.

The turnpike carries one of the heaviest volumes of traffic in the country — more than 46,200,000 trucks, cars and buses with over 1,350,000,000 vehicle-miles during 1959. To minimize interference with traffic flow, the Turnpike Maintenance Department and its contractors confine maintenance and construction operations on its roadways to midweek days during daylight hours. The ease and rapidity with which neoprene-modified asphalt can be laid down with standard equipment and the tenacity with which it holds stone aggregate on its surface immediately after laying have proven important factors in meeting maintenance and construction schedules.

Cutback asphalt—Grade RC-2 or RC-3—modified with 1½ percent of neoprene by weight and heated to 150 degrees Fahrenheit minimum or 200 degrees maximum is applied by a standard pressure distributor at an average rate of 0.3 gal. per square yard for seal coating on the existing 3-in. course of penetration macadam on the shoulders. The stone cover is ½-in. aggregate applied at a rate of 25 lbs. per square yard by tailgate spreaders or other

mechanical means. The cover is rolled with an 8-ton tandem roller.

The first installation of seal coating with neoprene-modified asphalt on the New Jersey Turnpike, made in June, 1959, covered six miles of inside shoulders between Newark and the south end of the Passaic River Bridge. The second, covering seven miles from the north end of the Hackensack River Bridge to the northern terminus of the turnpike, was made in late November. Neoprene-modified asphalt for both installations was supplied by the asphalt division of Century Chemical Corp.

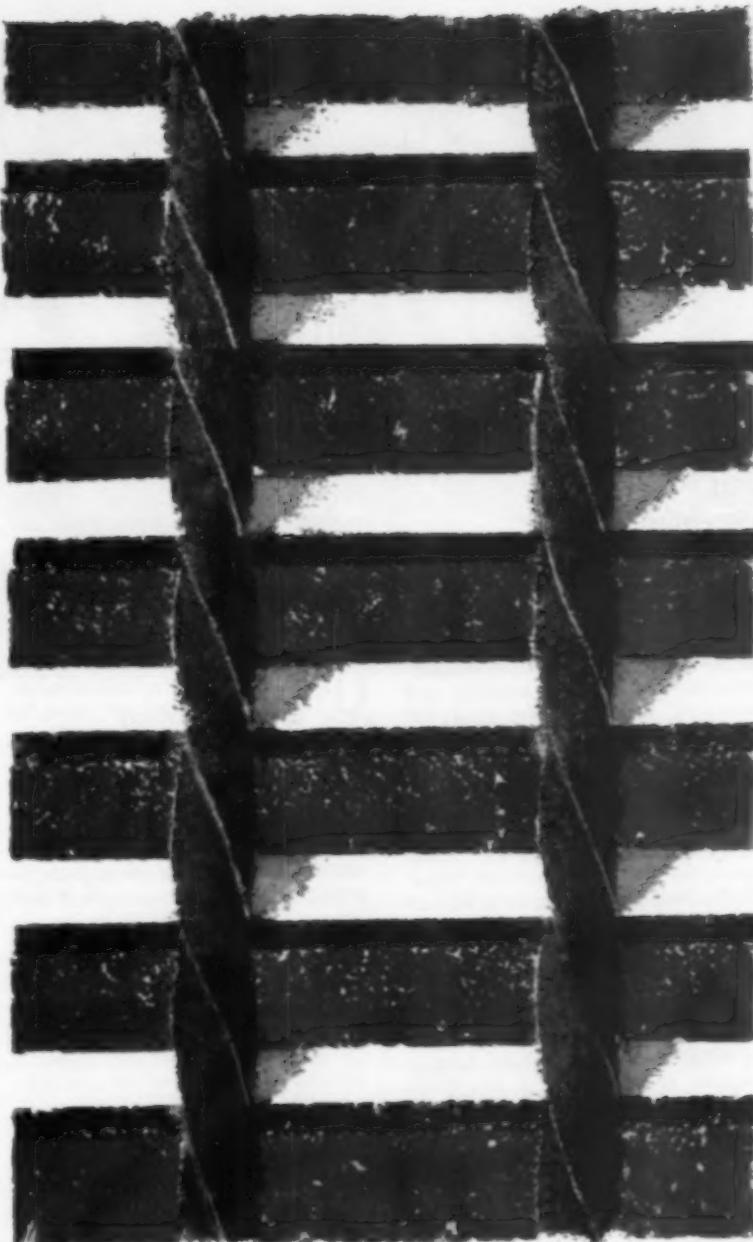
The initial adoption of neoprene-modified asphalt by the New Jersey Turnpike Maintenance Department was as a crack filler. Modified with 3 percent neoprene by weight—twice the amount normally used in surface treatments—the asphalt was first used in 1958 to fill longitudinal cracks developing in the traffic lanes. Because of the location of the cracks and their size—as great as an inch wide, $\frac{3}{4}$ -inch deep and 50 feet long in some cases—a rapid curing filler was needed.

In tests the neoprene incorporated without difficulty to produce a smooth, homogeneous blend. The asphalt emulsion remained very fluid and no difficulty was encountered in pouring it into the cracks. At present, this procedure is the standard method of maintenance because the neoprene-modified material cures faster than the regular material and the bonding action is superior, according to Mr. Goldberger.

The filling operation is accomplished by pouring the mixture of neoprene and asphalt emulsion, Grade RS-1, into the crack and covering with sharp, hard, manufactured stone sand. Excess loose sand is whipped off the roadway surface by traffic.

In a normal working day, the maintenance sealing crew is able to cover about one mile of three-lane pavement. The cost of this operation is variable. A good average for labor costs, however, would be about \$100 per day.

Neoprene-modified asphalt is also specified by the Maintenance Department for joint filling between concrete slabs and for sealing concrete or Belgian block pavement on underbridge slopes adjacent to bridge abutments. The neoprene-modified asphalt adheres to both block or concrete pavement, relieving the problem of water seepage under the surface and resultant damage to the pavement.

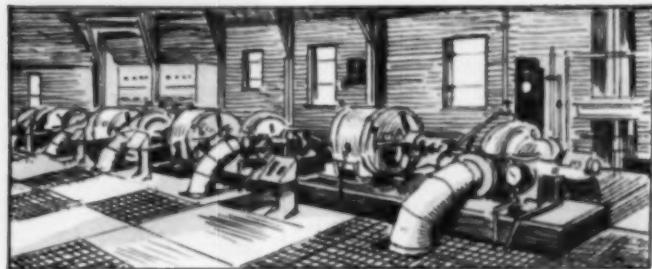


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Prepared by **ALVIN R. JACOBSON, Ph. D.**

Associate Professor and Head, Division of Sanitary Science, Columbia University School of Public Health

**Well
Stimulation**

A study has been made of the techniques of well stimulation, known variously in the water supply field as well development, redevelopment, or rehabilitation. At the same time, a critical preliminary analysis was made of existing and emerging techniques in crude-oil production which would be applicable to ground water production. It was estimated that more than 90 percent of the approximately 600,000 existing oil wells have been stimulated, some of them many times, in order to increase their production. The frequency of stimulation of the approximately 15,000,000 water wells in the United States would be very small indeed. The question arose as to whether there was a real reason for this limited application of a proven technique, or whether it came about largely because of well owners and those who make decisions for them being unaware of the possibilities of stimulation as used in oil production. A study was made of the technical performance factors in water well stimulation drawn from 870 actual stimulation cases in 141 counties of 24 states. For all types of treatment in all types of formations the median ratio indicated a 97 percent improvement over specific capacity that existed immediately before treatment, and a 20 percent improvement over the original production of the well. Failures to achieve any improvement over the treated well were 11 percent, whereas failures to achieve improvement over the original well were 43 percent. When considered by type of formation, the data show that success has been definitely greater in consolidated formations (141% improvement) than in unconsolidated formations

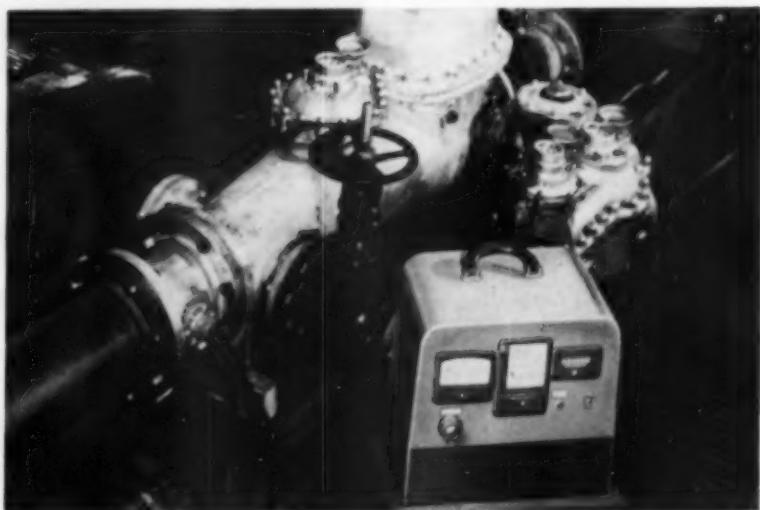
(45 percent improvement). When analyzed by treatment type, the data show a quite consistent pattern of effectiveness, the methods ar-

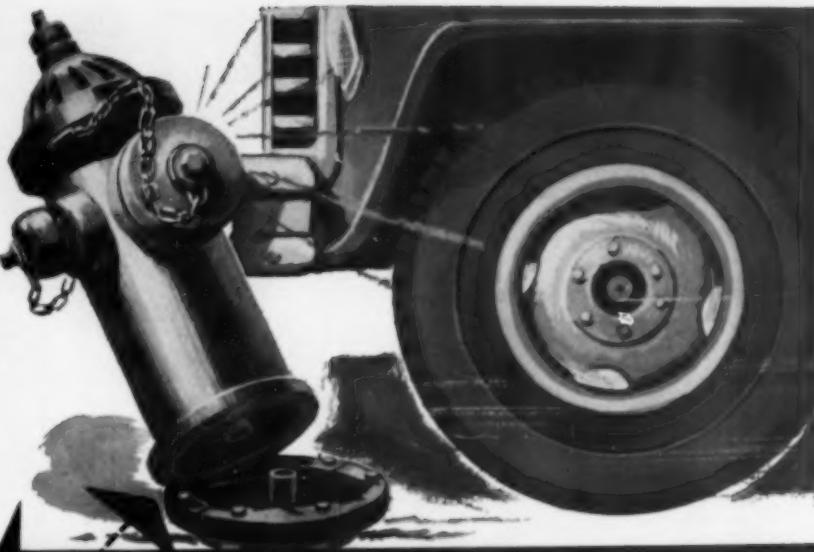
ranged in a descending order of effectiveness: 1) Fracturing; 2) pressure acidizing; 3) vibration explosion; 4) shooting, and 5) surging.

Flow Meter Uses Ultrasonic Waves

USING SOUND WAVES to measure the velocity of flow of water or sewage in a pipe is a joint development of Hersey-Sparling Meter Co. and Gulton Industries, Inc. The new meter has a primary measuring device consisting of a flanged bronze section of pipe across which ultrasonic waves are transmitted. The sound beam has a frequency of nearly 1000 kilocycles per second, produced in pulses at the rate of 200 per second. Echoes result which reflect a shift of the beam due to the velocity of flow. This shift is continually measured by the other part of the meter, a portable instrument which can indicate rate of flow, record and totalize. The ceramic transducer for transmitting the sound and the re-

ceiving crystals are mounted on the exterior of the flanged section, so that the interior is obstructionless. The length of this pipe section is such that it can replace a standard valve in a line, making the meter advantageous for checking the accuracy of large flow meters without removing them or interfering with the operation of the line. With the pipe section portion of the meter permanently installed at suitable locations, the portable indicator-recorder portion can be used for periodic flow tests throughout a system. It has application also for measuring sewage flow and for permanent installation as a flow recorder in plants. The unit may be powered by a 110-volt AC source or a 12-volt storage battery.





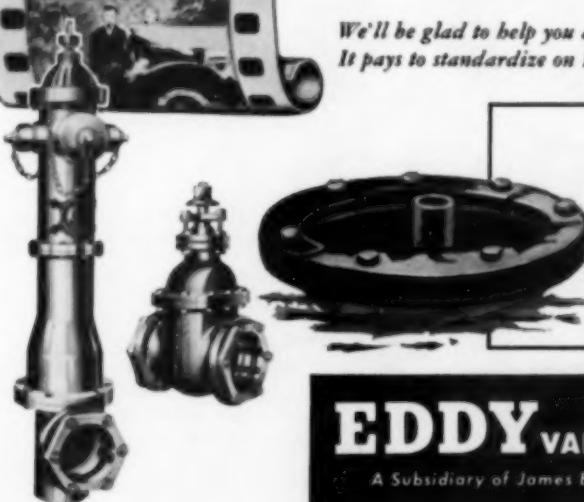
THIS DEMONSTRATION

proved the advantages of
THE NEW EDDY BREAK-FLANGE HYDRANT

• Clean breaking action of the new EDDY break-flange hydrant is clearly demonstrated in this film strip of a test made recently for Mr. Herbert Campbell, Town Engineer, Wayne, New Jersey. Just as it was designed to do, the hydrant broke off at the break-flange and the coupling sheared at the weak point.

Mr. Campbell was so impressed that he changed the specifications on the spot...wrote new specifications around the EDDY Hydrant. Another EDDY feature which appeals to economy-minded waterworks officials is that these hydrants, with the break-flange feature, are the same as standard EDDY models in all other respects. Working parts are interchangeable and no separate inventory of repair parts is required.

*We'll be glad to help you arrange a similar demonstration.
It pays to standardize on EDDY hydrants and valves.*



NO HARM TO HYDRANT...

As shown, the safety stem coupling shears off at the ground line. The break-flange gives way without damage to stand pipe or nozzle sections. With break-flange construction the hydrant is easily and economically replaced without digging or costly repairs.

EDDY **VALVE COMPANY**

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H. W. CLARK CO.
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STYLE A—Clark Service Box for use with iron pipe.

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STYLE B—for use with lead
(illustrated) or copper
pipe.

It is concluded that stimulation could probably be much more widely applied to improve ground water production.

"Survey and Analysis of Well Stimulation Performance." By Louis Koenig, Research Consultant, San Antonio, Texas. *Journal A.W.W.A.*, March, 1960.

USPHS Chemical Limits

USPHS drinking water standards were first adopted in 1914, but the 1925 revisions provided the first numerical limits for specific chemicals. The most recent modifications were made in 1946 and are still in use. These drinking water standards have become widely accepted as effective and fair. The present standards provide maximum permissible limits (expressed in parts per million) for the following chemicals: Lead 0.1; fluoride 1.5, arsenic 0.05, selenium 0.05, and hexavalent chromium 0.05. These have been established because of their known or suspected physiologic effects. In addition, recommended limits are provided for the following chemicals: Copper 3.0; zinc 15; iron and manganese combined 0.3; magnesium 125; chlorides 250; sulfates 250; phenols 0.001, and total solids 500. The standards are recommended for these chemicals because of their potential taste, odor, staining properties, or indirect physiologic effect. Certain alkalinity requirements are also provided to prevent overtreatment of water with chemicals. The present limits for all of these chemicals appear to be satisfactory; however, consideration should be given to providing limits for cadmium, cyanides, nitrates, and radioactive material. All four of these water pollutants are suspected of potential physiologic effects.

"Significance of Chemical Limits in USPHS Drinking Water Standards." By Gene B. Walsh, San. Engr., Div. of Eng. Services, USPHS, Washington, D. C., and Jerome F. Thomas, Assoc. Prof. of San. Chemistry, Univ. of California, Berkeley, Calif. *Journal A.W.W.A.*, March, 1960.

Good Watershed Management

A good example of the development of a watershed management program and of a city's reliance on forest protection of reservoir shorelines is that of Baltimore, Maryland. The City owns 17,300 acres of watershed land surrounding the City's



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there's no need to disturb traffic to replace mains. Over 6,000,000 feet of piping, from 4" to 144" diameter, have been treated by Centriline. *Ask your neighbor.*

Write today for a list of nearby officials whose cities have cut inconvenience and costs with this pipe-saving process. Hear what they have to say about Centriline. Then write or call us. We'll be glad to show you how Centriline can help you solve the problems of pipe conditioning.

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three water supply reservoirs: Loch Raven, Prettyboy, and Liberty. Sedimentation has been a continuing problem since Baltimore's first water-supply reservoir was built in 1862. In fact, the first reservoir, Lake Roland, was abandoned as a result of silting. Within recent years, watershed management has undergone important changes. The program has been developed to serve the dual purpose of timber production, and through controlled forest use, better water production. To bring about a change in program, a Watershed Control Division was

created in 1954. A timber-cutting program was initiated in 1955 on Loch Raven watershed. Stand improvement is a primary objective: Overmature, defective, and low-vigor trees are marked and cut, releasing the more vigorous growing stock. All logging is done by the Water Bureau's own labor force and almost all the timber is cut at the Bureau's own sawmill. About 6,441,000 board feet of lumber were produced over the past four and a half years. Of this, 5,834,000 board feet were disbursed at a value of \$519,853.59—an average of \$12,090

per month. A well-designed and well-constructed permanent road system has been established which has several economic benefits: 1) Log hauling is faster, and easier on equipment; 2) being permanent and easy to maintain, roads will be available for future logging; 3) roads are available for other access, chiefly for fire control. To complement its management activities, the City of Baltimore is conducting several cooperative research projects on its watersheds to guide the watershed management on reservoir lands, but also to evaluate the effect of forest planting and other practices on the watershed areas above the reservoirs.

"The Baltimore Watershed . . . An Example of Good Management." By Irvin C. Reigner, Research Forester at the New Lisbon (N.J.) Research Center of the Northeastern Forest Experiment Station, U. S. Forest Service, and Walter C. Sushko, Forester, Water Supply Bureau, City of Baltimore, Maryland. PUBLIC WORKS, April, 1960.

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The AMERICAN "Aircomb" has very useful application in pre-aeration, channel diffusion, and activated sludge installations. It is especially preferred where relatively high tank content agitation is required and where other types of diffusers present operating difficulties due to clogging.

The "Aircomb" handles a very wide range of gas flow per diffuser unit. Orifices automatically adjust to the gas flow (the gas-liquid interface lowers as the rate increases). Bubble size also is smallest at the lowest flow. Velocities are self-cleansing.

The "Aircomb" is also the ideal diffuser for recarbonation, since carbon dioxide will go into solution readily. No maintenance is required.

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It can be applied in a wide variety of mechanical arrangements, such as shown on header pipe illustrated below. More than one header with aircombs can be used parallel to each other as needed. Peaked-dome of the "Aircomb" prevents the accumulation of solids when used in settling tanks.

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The complete "American" line includes sewage, industrial waste, and water purification equipment, tank and pipeline mixers; deep well turbines; water transfer, clear liquid and waste water pumps. Consult "American" engineers or write for technical data.

WHICH MIXING EQUIPMENT

provides most efficient flocculation?

LINK-BELT's combination of flash and straightline

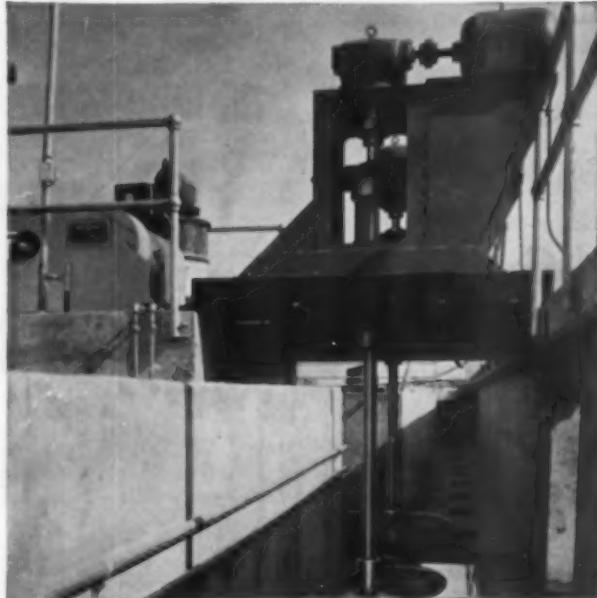
mixers assures chemical savings of 30 to 40%...

increases filter runs by 50% . . . decreases wash water demands

FLASH MIXERS PROVIDE RAPID, THOROUGH MIXING of chemicals with water, sewage or industrial liquids. They consist of a constant-speed motor directly connected to a quiet-operating worm gear reducer. This drive, mounted on a pedestal, is connected to a vertical propeller shaft so mounted that *underwater bearings are not required*. Load and thrust of the propeller shaft are taken up by bearings in the pedestal so these forces do not act on the reducer bearings. This efficient design assures long life and trouble-free operation. The propeller itself is an iron casting designed for high mixing efficiency with low horsepower requirements. Link-Belt flash mixers may be installed in concrete, steel or wood tanks by mounting on a steel or concrete platform spanning the tank walls.

Straightline Mixers Provide Gentle Slow Mixing to build up maximum size floc. These mixers consist of a number of sections, each made of a horizontal solid steel shaft carrying steel angle arms on which redwood paddles are mounted. The paddle shaft is driven by a chain drive from a Link-Belt Electrofluid drive coupled to a Link-Belt P.I.V. variable speed drive. The solid steel paddle shaft, with rigid compression couplings insuring perfect shaft alignment, turns in special babbitt bearings with water lubrication grooves. These bearings eliminate grease contamination of the water and prevent breakdown that may be caused by failure to provide proper lubrication. Use of redwood for paddles eliminates painting maintenance. Link-Belt makes a complete line of these mixers. Size and shape can be adapted to suit local requirements.

The mixers shown above are part of the broad line of Link-Belt sanitary engineering equipment. Get in touch with the Link-Belt office nearest you. Our sanitary engineers will be glad to work with your engineers, chemists and consultants . . . help you get the finest in modern treatment methods. Or write for your copy of Equipment for Chemical Flocculation Book 2442.



LINK-BELT



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per-structure. Approximately 8 feet of headroom has been provided in the operating gallery to provide ease of entrance and exit for the operator. The plant was designed for completely automatic operation through the use of a pneumatic-type control system. The design of the plant provided for future expansion through an "in-line" layout, with pretreatment and coagulation on one side of the filter gallery and the four filter cells on the other. These and other innovations have provided a water plant at approximately \$100,000 below normal cost.

"Nonstandard Design and Bidding Cut Filter Plant Costs \$100,000." By V. A. Vaseen, Ripple & Howe, Consulting Engineers. *Water Works Engineering*, March, 1960.

Twice the Plant for Half the Money

Vertically-tiered sedimentation basins, mud valves, and the use of high-service pumps as filter rate-of-flow controllers are some of the innovations that have saved money for the Wanakah Water Company, a private water company that has been furnishing water to the Wan-

akah, N. Y., area since 1896. Economy was essential, as a maximum of \$140,000 was budgeted for providing the additional million gallons of water daily. The consulting-engineering firm of Thomas M. Riddick & Associates designed the plant consisting of a four-tiered and hydraulically cleaned flocculation - sedimentation basin. The top tier consists of the aeration basin and a three-section flocculation basin. The next three tiers are sedimentation basins. A vertical wall divides these basins into two parallel units. Further economies were effected by the use of mud valves instead of regular gate valves to drain the sedimentation basins and raw-water inlet channel. The resulting high velocities when the 24-inch mud valves are opened help flush out most of the sludge that has settled out in the basin.

Aeration and rapid mixing of chemicals is provided by means of a positive blower discharging through a series of air diffuser assemblies. The water entering the plant from Lake Erie receives successive applications of activated carbon, forced-draft aeration, primary chlorination, and additional aeration for the removal of tastes and odors. Alum is then added for coagulation, with silica and calcite applied when needed. After flocculation, sedimentation, and filtration, soda ash is added to the finished water for pH adjustment before it is pumped into the distribution system. Based on design capacity, this plant cost approximately half as much as one of conventional design.

"Twice the Plant for Half the Money." *The American City*, March, 1960.

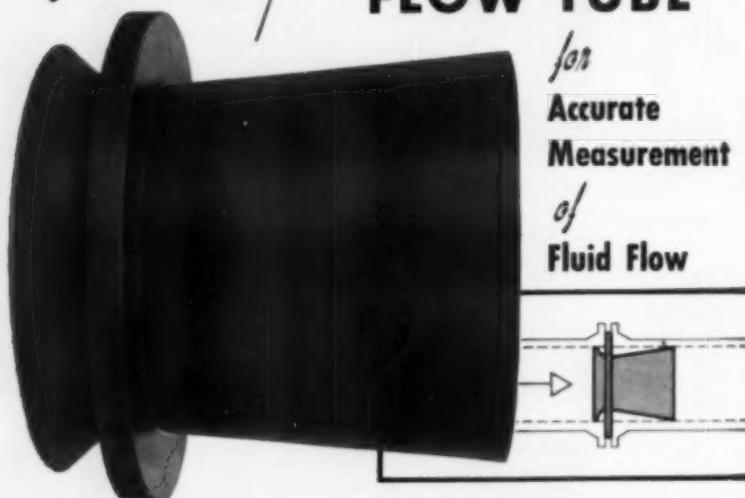
Waxahachie's Surface Supply

When increasing demands forced the city to investigate various means of increasing its water system, the city officials retained a consulting engineering firm to make a survey and present a plan. After investigation, the engineers recommended a dam and lake on the South Branch of Waxahachie Creek. The \$1,500,000 estimated total cost was based on the construction of an earthfill dam on the creek, gravity flow to a raw-water pumping station, pressure transmission to a new treatment plant and gravity flow to a central pumping station serving the distribution system. To finance the project a water district was formed and combination tax and revenue bonds were issued, backed by a

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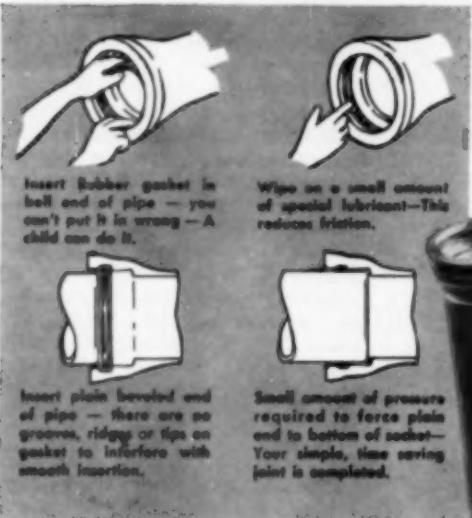
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For a complete list of our products see our inserts in CHEMICAL WEEK BUYER'S GUIDE, Pages 173-176 or CHEMICAL MATERIALS CATALOG, Pages 551-554. For more detailed information make request on your firm's letterhead.

TC TENNESSEE CORPORATION
GENERAL OFFICES: 1500 GRANT BUILDING, ATLANTA 3, GEORGIA

5-mill (50 cents per \$100 assessed evaluation of property) levy and sale of water to the city. A 4,740-foot-long earthfill dam was constructed, thereby forming a reservoir having an area of 687 acres, to be also used as a recreational facility for fishing, boating and picnicking. A 20-inch transmission line was connected to the treatment plant providing a nominal capacity of 2,500,000 gallons per day. The plant features a Dorco Clarifloculator, rapid sand filtration, tele-metering and central control of most system facilities. Copper sulfate

prevents growth of algae and other odor-producing organisms. In addition, a carbon slurry is injected into the transmission line near the raw water inlet and is also fed into the outfall end of the Clarifloculator by siphon, to remove remaining tastes and odors. A 750,000-gallon elevated storage tank and some new distribution mains were constructed with the remainder of the bond money. Three of the five driven wells which have served this community as the only source of water have been converted into a standby auxiliary supply.

"A Surface Supply + Water Security." By H. R. Yungmeyer. *The American City*, March, 1960.

Other Articles

"Safety Costs Less" no matter how insignificant the accident. By George C. Sopp, Joint System Head & Asst. Mgr., Dept. of Water and Power, Los Angeles, Calif. *Water & Sewage Works*, March, 1960.

"Distribution of Soil Conductivity and Its Relation to Underground Corrosion." A comprehensive discussion of the statistical analysis of soil resistivity in its relation to corrosion. By Gordon N. Scott, Consulting Engineer, Los Angeles, Calif. *Journal A.W.W.A.*, March, 1960.

"Techniques and Economics of Calcining Softening Sludges." A joint discussion presented on July 14, 1959, at the Annual Conference, San Francisco, Calif. "Calcination Techniques." By William B. Crow, Cons. Engr., Black & Associates, Inc., Gainesville, Fla., and "Miami Lime Recovery Plant." By Claude F. Wertz, Director, Dept. of Water & Sewers, Miami, Fla. *Journal A.W.W.A.*, March, 1960.

• • •

New Power Crane-Shovel Rating Standards

A new and uniform method of rating full-revolving power cranes has been adopted by the Power Crane and Shovel Association. This action was taken to reduce confusion and to permit distributors, purchasers and users of power cranes to compare machines on a uniform and equitable basis. The method is:

1) Crawler - mounted, truck-mounted, and wheel-mounted cranes will be rated on the basis of the maximum load, in tons, at the radius selected by the manufacturer, in accordance with Commercial Standards CS90-58, paragraph 6.06.

2) The crane rating will be supplemented by a second group of numbers to designate the Association classification into which the crane falls. This identification will consist of two numbers, as follows: a) The crane rating radius, in feet, of the maximum rated load, with base boom length, as determined under Paragraph 1. b) The rated load (expressed in pounds divided by 100, and rounded off to the nearest whole number) at 40-ft. radius, with 50-ft. boom length.

3) The above values are to be based on the crane ratings in the direction of least stability, with outriggers set, if the machine is so equipped.

The Association is taking steps to have this method incorporated into the Department of Commerce, Commercial Standard CS90-58.

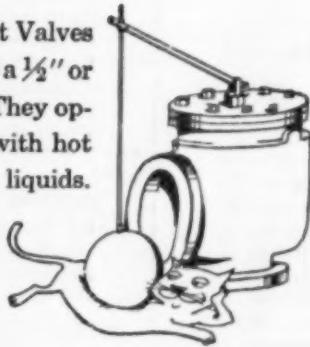
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Sensitive Golden-Anderson Float Valves automatically hold water level to a $\frac{1}{2}$ " or 1" variation in tanks, bins, etc. They operate at high or low pressure—with hot or cold water—and most other liquids.

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Foxboro Control Cabinet at Loring Air Force Base Water Treatment Plant. Cabinet contains:
1) top left — indicator for filtered water to

clearwell 2) lower left — indicating controller for filter level 3) lower right — recorders for flow rates to filters.

It's Foxboro automatic control for new Loring Air Force Base water treatment plant

Five Air Force operators, the Little Madawaska River, and Foxboro Automatic Control . . . that's the water-supply team at the 10,000-man Loring Air Force Base at Limestone, Maine.

Completed in 1959, the new facility features the most advanced automatic control. Reservoir, clearwell, filters — all have flows and levels maintained automatically. There are no valves to crank, no visual checking to do. In fact, filter backwashing is the only manual push-button operation there is.

The five operators are all enlisted Air Force personnel. Since none had previous experience in any phase of water treatment, they were all thoroughly trained by Foxboro before the plant's start-up.

If you want to save time — save money in the operation of your plant, investigate Foxboro automatic control. Bulletin 1-15A has full details — write for it. The Foxboro Company, 265 Norfolk St., Foxboro, Mass.

*Reg. U.S. Pat. Off.



Water Treatment Plant at Loring Air Force Base has a capacity of 4 million gallons per day. Foxboro Teletax* Telemetering is used to link it with base facilities, some 5 miles away.

FOXBORO
REG. U. S. PAT. OFF.

TRAINING Swimming Pool Operators in Texas

ROBERT B. WHITE,

Senior Engineer Assistant,

Texas State Department of Health

IT IS elementary to say that swimming pools should exist primarily for recreational purposes. Every effort should be made to maintain an atmosphere of pleasure, relaxation, and enjoyment in and around a swimming pool. Likewise every effort should be made to operate pools so they will not be a health hazard or nuisance.

For many years it was the purpose and desire of the officers and members of the Texas Beach and Pool Association, and of the Local Health Departments and the Texas State Department of Health, as well, to crystallize a training program for swimming pool operators in Texas.

An approved plan was prepared during 1955, and in 1956 the first pool operators' training courses were initiated. These schools were, and still are, conducted on a voluntary basis in Texas, in a number of selected locations throughout the state. Upon completing the course of instruction, the operator may take a written examination and if he makes a passing grade of 75 or better and possesses the necessary pool operation experience (one year) he will be issued a certificate of competency by the Texas State Department of Health.

The general emphasis or philosophy brought out at these schools is the fact that swimming pool operation is not a pin point mathematical accomplishment. On the other hand, and in terms of good public health practice, one cannot use a bit-or-

miss or careless method of operation.

All phases of pool operation, maintenance, safety and sanitation are considered by the instructors at these schools. If this information is disseminated properly, the operator usually will be able to pass the examination and will be qualified to receive a certificate. However, we have found that from 5 to 10 percent of the operators are not qualified and do not pass the test. The certificate when issued is valid for three years. It may be renewed upon its expiration date if the operator has registered and has attended one of these training courses during the three-year period in which it is valid. Providing the certificate expires and an operator wishes to renew it, he will then have to attend another course in pool operation and pass the examinations, which are revised every year.

In 1956, 634 operators attended some 12 schools. By 1957 the attendance slipped down to 536 at 15 schools; but by 1958 it was up to 798 at 15 schools and in 1959, our total attendance at 21 schools had grown to 840 operators. The grand total of attendance is now 2,504. There were 419 certificates issued in 1956; in 1957, 216; in 1958, 254; and

choice

...based on responsibility...

...can make a difference...

in 1959, 370. The grand total to date is 1,209. It is evident by these figures that the training of swimming pool operators in Texas is booming.

An interesting facet of this training program is that in 1958 and 1959 bi-lingual schools were conducted in Laredo and Nuevo Laredo. The instructor would lecture on a particular subject in English for several minutes and then an interpreter would translate what had been said to a representative group from Mexico in Spanish. This sort of relationship not only helps to increase good public health practices at pools in Mexico but is also an excellent medium for the promotion of better public relations between the United States and Mexico. The Mexican representatives were extremely responsive and very appreciative.

When the training program began in 1956, there was very little to go on except the use of verbal instruction. However, we now are able to offer the operators a great deal more. Packets of printed material pertaining to private, semi-public, and public pool operation are distributed to each operator. Slides, visual aid charts and a 20 minute 16-mm film on "Home Pool Care" are usually shown. Such visual aids are ex-

tremely valuable in pointing out certain technical features in pool operation. Coupled with this, the Texas Beach and Pool Association has just made available a Pool Operator's Training Manual which will include perhaps more visual displays than any other comparable publication on the market today. This manual is probably the largest endeavor the Association has undertaken since it was organized 32 years ago.

In conclusion it might be pointed out that Texas is not the only State that is carrying on pool operator training programs, although we feel that the Texas Beach and Pool Association was the prime-mover, so to speak, in creating nation-wide interest. Courses are now carried on in Florida, Louisiana, Canada, California, New Mexico, Illinois and Oklahoma; and here in Texas we are looking forward to an improved and more expanded program in 1960.

Editor's Note—Those interested in obtaining a copy of the Manual mentioned in this article should address their requests to George Lowrey, Jr., Treasurer, Texas Beach and Pool Association, 1/2 Austin Recreation Dept., P.O. Box 1160, Austin, Texas. The price is two dollars.

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YOU are CIVIL DEFENSE

LEO A. HOEGH,

Director,

Office of Civil and Defense
Mobilization

AS YOU read this article keep in mind that you are a vital part of civil defense. In the final reckoning you will make it work. Government can, and is doing, much of the job. But government cannot do the whole job.

In the simplest terms, only you can do many of the things that must be done for survival. The mission of the Office of Civil and Defense Mobilization is twofold: 1) to help you perform these individual tasks; and 2) bring into being the facilities and organization essential to live through nuclear attack.

To understand the magnitude of this mission it is necessary to appreciate the massive challenge faced by the United States today.

For 325 years—from 1620 to 1945—America was protected by two oceans. Then the natural barriers fell before the onrush of new technology. At first this scientific leap was difficult to accept. In brief, new weapons and new delivery systems had worked a revolutionary change in the requirements of national security.

We know that the Soviet Union can hit a great number of key industrial and population centers of our Nation. This is the harsh but unavoidable truth of the hydrogen age.

The counterpoise to this peril is the retaliatory strength of the United States and its allies coupled with the ability to survive. In a message to the Senate in August last year, President Eisenhower termed this combination "total defense." He said "Survival cannot be guaranteed merely with a capacity for reprisal. Equally important is our ability to recover. This means staying power and endurance beyond that ever before required of this nation or any nation. . . Our total defense is incomplete and meaningless without a reliable and responsible home defense."

It will take common sense, good will and high statesmanship as never before to protect civilization

from this awesome threat. A single error in judgment, an accident, or an insane impulse could plunge the world into war.

It is true that nuclear knowledge abounds in peaceful potential, but equally abundant are the destructive ways in which it could be used.

These are the reasons for civil defense.

OCDM has a national headquarters in Washington and an operational headquarters at Battle Creek. There are eight regional offices, located at Harvard, Mass.; Olney, Md.; Thomasville, Ga.; Battle Creek, Mich.; Denton, Tex.; Denver, Colo.; Santa Rosa, Calif.; and Everett, Wash.

The plan for Civil Defense and Defense Mobilization, promulgated by President Eisenhower in October, 1958, is the framework for all programs in civil defense. It outlines responsibilities of the Federal, State, and local governments, industry and individual citizens and describe the measures to be taken now as well as in the period following an attack. Under this plan, OCDM provides advice and guidance to State and local governments in the development of their survival plans. OCDM leads in developing a national radiological defense plan, a national attack-warning system (NAWAS) and protective measures to save lives and minimize damage in the event of enemy attack. Nationwide warning is now possible in less than one minute via the NAWAS leased telephone system connecting OCDM warning offices at the North American Air Defense Command (NORAD) headquarters with more than 300 strategic warning points.

The National Policy on Fallout Shelter, announced in May, 1958, underscores the importance of protection from radioactive fallout. The policy has 5 major aims: 1) to educate all Americans on the facts about fallout and ways to minimize its effects; 2) to survey existing structures to determine capabilities for fallout shelter, particularly in large cities; 3) to accelerate research on incorporating fallout shelters in existing and new buildings; 4) to construct a limited number of prototype shelters of various kinds for



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In addition, the conical disc's center of gravity is slightly above the center of the ball, resulting in still further sensitivity over a flat shape. The Hersey Conical Disc Piston assures you of the continued accuracy that helps maintain maximum revenue. Write us for descriptive catalog No. H2.

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testing; and 5) to give leadership and example by incorporating fallout shelters in appropriate new and existing Federal buildings.

An OCDM booklet, "The Family Fallout Shelter," has been a pace-setter for this new campaign. This manual, containing blueprints for fallout shelters costing as little as \$150, is available free of charge. More than 15 million copies have reached the public.

A Nationwide radiological defense education program is now available in more than 8,000 high schools and colleges. OCDM has purchased and

is distributing 900,000 radiological instruments for this program.

A Federal radiological network has 1,000 fixed monitoring points operating around the clock. By 1962 there will be 3,000. Along with State and local monitoring by more than 14,000 stations, this network will help all levels of government to protect Americans and speed recovery. We will have an additional 3,000 Federally operated monitoring points and 130,000 State and local points by July, 1963.

Recently a rural civil defense program was put into effect. Its goal is

to encourage the construction of rural family shelters and educate rural families in the protection of people and of livestock and crops.

Of specific interest are the survival plans developed by all States and 240 metropolitan areas. By late 1959, this planning at the local level involved 2,315 areas with several hundred additional plans now being put into effect.

Another important milestone in civil defense is Public Law 85-606, enacted in 1958. This law amended the Civil Defense Act of 1950 by establishing civil defense as the joint responsibility of the Federal Government, the several States, and their political subdivisions. PL 85-606 also authorizes the Federal Government to give financial help to the States for personnel and administrative costs in civil defense. Funds have not yet been appropriated for this program. The President requested these funds in his budget message of January 18, 1960.

A Continuity of Government Program has been carried forward over the last year. By the end of 1959, legislatures in 43 States had taken some action on legislation suggested by OCDM to provide for emergency lines of succession, preservation of essential records, government emergency relocation sites, and the full use of government facilities, equipment and personnel in emergencies. Governors of 34 States have signed all or part of this important program into law.

The attainment of specific goals discussed here is of direct concern to every American. It isn't that we expect an attack, or predict an attack. The urgency stems from the power of today's weapons and the means of delivery of these weapons. If we are ever attacked, survival for days or weeks could be starkly personal.

Here is what you personally, and your neighbors, must do NOW to protect your loved ones: Know the warning signals and what they mean; know your community plan for emergency action; provide protection from radioactive fallout—home fallout shelter; learn first aid and home emergency preparedness; get acquainted with CONELRAD—640 or 1240 on your radio dial—for official directions in emergency.

In an early issue Barent F. Landstreet, Deputy Assistant Director of OCDM Emergency Community Services, will have an article directed to public works engineers and officials. It will cover sewage, water, waste disposal, road repairs, and debris removal.

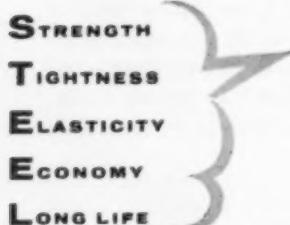
OMAHA chose STEEL PIPE for FEEDER MAIN



... every length was hydrostatically tested in the shop to AWWA standards!

Maximum length and minimum wall thickness, as only steel pipe provides, enabled the Metropolitan Utilities District of Omaha to install a big pipe line through a quiet residential district with little inconvenience. Only 180 ft. of narrow trench was open at one time to install the coal tar enamel coated 48 in. diameter, $\frac{3}{8}$ in. wall thickness steel pipe in 40 ft. lengths.

Workers of the Metropolitan Utilities District, under the direction of General Superintendent Kenneth Young, are shown lowering a section of pipe into place in the trench just a few feet behind the digger.



...these are inherent qualities of fabricated steel pipe. Compare steel pipe with other types ... you'll see why "wherever water flows, steel pipes it best." You can always specify steel pipe with confidence.

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NOW... a 25% to 30% further increase in filter cleaning efficiency

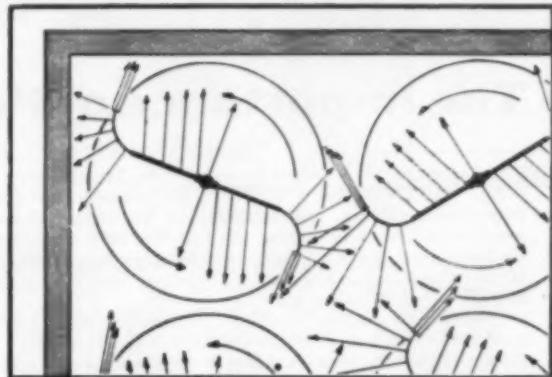
Actual field tests show the new S-Type unit gives a 25 to 30% further increase in filter cleaning efficiency, with resultant increase in over-all plant efficiency. The old straight arm type of Agitator increased filter production beyond filter design. And now just a moment's study of the sketch below will show how much better this newly-designed S-Type will perform.

With it each of the corner and void areas will now receive **four** agitating impulses per revolution instead of two with the old style straight arm, thereby doubling the cleaning action in these areas. See drawing below.



Portion of an
S-Type Filter
Arm in
actual service
(patent pending)

New S-Type Filter Arms double the cleaning action.



COMPLETE COVERAGE OF ENTIRE FILTER AREA

See how the jets on the forward and following curved portions of the rotating arms give complete coverage of the entire filter area. Nozzles are now also angled downward and outward from the center to create a positive re-circulation of expanded media throughout the entire filter bed. As a result no portion of the filter media is excluded from thorough cleaning action.

CAN BE ADAPTED TO OLDER UNITS

The design of the S-Type installation is such that older units in service can be modified to take full advantage of the advanced features. The past records of Palmer equipment are your assurance of satisfaction. The new model will carry the same guarantee of minimum operational cost. Replacement parts last year totaled slightly over \$1,200, for well over 15,000 units many of which have operated for 10 to 25 years.

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See Our Exhibit At The AWWA Convention, Miami Beach, Booths 77-78

Electronic Surveying Instruments for Water and Land Distance

Two new surveying instruments have been developed for the civil engineering profession, each designed for special problems.

One, the "Aero-Dist," is a device for measuring ground distances from the air. It will enable surveyors to carry their lines across bodies of water or to jump over areas of inaccessible terrain in order to establish ground controls (or bench marks) for construction of power plants, highways and irrigation schemes in remote places.

The other instrument, the "Hydro-Dist," is a device to measure distance from land to sea points. It may be used to provide continuous location data to construction men on offshore projects.

Both devices are electronic systems, based on the principle of the Tellurometer System. A series of high-speed impulses are transmitted from a small master unit at one point to a remote unit at the other point. The time required is recorded in billionths of seconds, then translated into miles, feet and tenths of feet.

The Aero-Dist consists of a mas-

ter unit carried by a light plane or helicopter, and two remote units on the ground. A remote unit is set up at each edge of the area to be measured. The airborne master unit is flown across the non-intervisible line between the two stations and transmits micro-waves simultaneously to both remote units. As the plane approaches the line and crosses it, a series of measurements to each remote unit is automatically recorded at the master unit. The straight line between the two ground stations shows up as the shortest distance. Thus, horizontal control for a construction project could be carried over a mountainous or forested area by one short flight.

Another potential use could be to maintain a continuous record of the exact location of a plane taking aerial photographs at exposure intervals. This could be of considerable value to photogrammetrists, plotting highway route locations by aerial methods.

A triplex system has also been developed utilizing three ground units. This would permit surveyors to establish two or three entirely new positions in relation to each other, or a third position in relation to two existing positions. The value of this application would be in extending existing horizontal control. This technique is actually equivalent to trilateration from the air, inasmuch as it is the measurement of the distances between points (or sides of a triangle), with proper allowance for the elevations involved—the plane and ground stations. The Aero-Dist has been designed to produce an accuracy of 1:100,000 plus-or-minus one meter.

The Hydro-Dist is expected to replace largely the sextant angle procedures used in hydrographic (offshore) survey, where its chief advantage is its ability to operate through fog or darkness.

As in the case of the Aero-Dist, distance is determined by means of radio magnetic impulses, in this situation from the vessel (or offshore job site) to remote stations on shore.

A semi-permanent installation could be used by engineers concerned with keeping a dredge on course in a river or harbor. Remote units on shore could be installed to provide continuous location data to the dredge. Operators would not be required to man the shore stations, and inclement weather or darkness would not hamper the system. The Hydro-Dist has been designed for an accuracy of about a meter within a 20-mile range.



The Importance of People

The future of U. S. water supplies rests largely with the American public. The knowledge of the hydraulic engineer, the skill of the operating mechanic, the craftsmanship of the manufacturer who makes water works supplies—these can function only as authorized to do so by the general public. Water works have become mostly public utilities. Water works improvements are therefore done with public funds, and it is the people who say yes or no.

Perhaps the greatest handicap in development of water supplies for over three-quarters of a century is the public opinion that water is cheap, simply because in pioneer days well water and spring water were free. This popular misconception has kept water rates too low to finance improvements as needed. Result: A 30-year-period of delay and a \$41 billion deficit in funds for water works and sewage works construction needed to meet today's requirements.

"Where there is no vision, the people perish," says an Old Testament Proverb. The first and the biggest job of water works men and city officials now is to inspire vision in the people of their community. Once they know the facts, the people will act for their own welfare.

This series is an attempt to put into words some appreciation of the water works men of the United States.

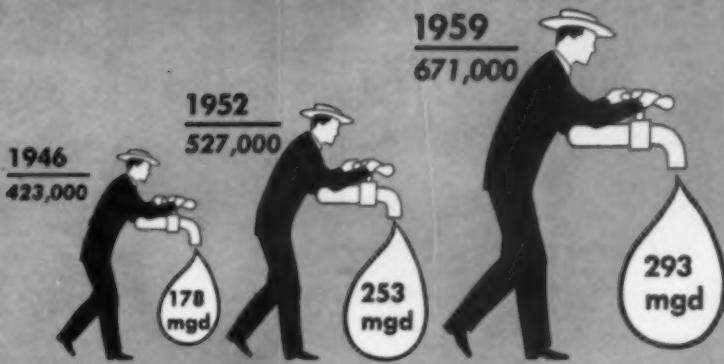


**M & H VALVE
AND FITTINGS COMPANY**
ANNISTON, ALABAMA



MICROSTRAINING® solves Denver's Water Problem

THE PROBLEM

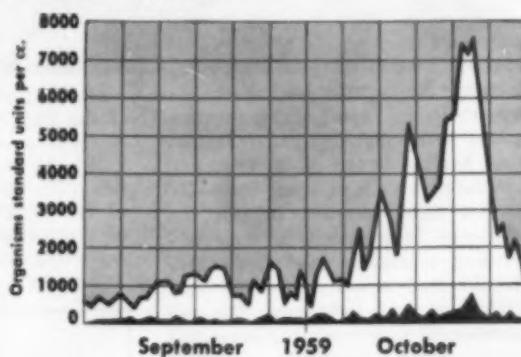


RISING DEMANDS NEED LONG DISTANCE PLANNING

Denver has always been proud of its reputation as a progressive City with an intelligent anticipation of the area's fast growing demand for water. The Blue River Diversion Project, the Roberts Tunnel and the Dillon Dam utilizing water from west of the Continental Divide are examples of this far sighted policy. Coincident with the arrival of the new supply from this source adequate treatment works will be needed which are sufficiently flexible to meet peak demands shown above during the summer at an economical cost without sacrificing quality. In consequence, the Board's engineers decided to investigate the application of the MICROSTRAINING process to water from Marston Lake which will be used as storage for the additional supply also.

THE TEST

Stringent field and laboratory tests were, therefore, carried out on Marston Lake water commencing June 1958 using a standard 7½' dia. x 5' wide unit. Average removals of micro-organisms to date are as high as 90% and a typical period is shown on the accompanying graph.



THE SOLUTION

Following these successful results, the Board instructed their Consulting Engineers, Phillips-Carter-Osborn, Inc. to design a MICROSTRAINING installation to treat 120 million gallons per day. The plant will be constructed incrementally and for the first 40 mgd Glenfield & Kennedy, Inc. are supplying eight 10' dia. x 10' wide machines to be commissioned by February 1961. Full advantage will thus be taken of the flexibility of such an installation which can be augmented as the demand for water increases at minimum cost with the least disturbance to existing facilities.

For Further Details, Visit
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THE
SEWERAGE
AND
REFUSE
DIGEST



Prepared by **ALVIN R. JACOBSON, Ph.D**

Associate Professor and Head, Division of Sanitary Science, Columbia University School of Public Health

Trickling Filter Performance

The efficiency of trickling filters under various hydraulic and organic loads was investigated over a period of 18 months at Michigan State University. An experimental filter was used which consisted of 7 vertically suspended $\frac{1}{2}$ -in. wire mesh screens, arranged in parallel and spaced 2 in. apart. Settled sewage from the East Lansing sewage treatment plant served as basic feed to the filter and whey was added to increase the organic load when required. In the report of this investigation it is noted that general practice has been to plot efficiency against organic load, using the well-known NRC formula. In this the efficiency is assumed to vary according to organic load alone. Hydraulic load is not considered as a factor, or only indirectly. The experimental data presented show that within certain limits the hydraulic load is the factor governing efficiency, rather than the organic load. The apparent agreement between actual filter efficiencies and those predicted by the NRC formula may be explained by the fact that this formula was developed for municipal wastes with a fairly narrow range of BOD values, say from 100 to 200 mg/L. Experimental data presented show that: 1. At constant hydraulic loads the efficiency of a trickling filter remains constant for organic loads up to 11 lb of BOD per day per cubic yard; and 2. The fraction of BOD remaining is proportional to the two-thirds power of the hydraulic load. An equation is presented relating filter efficiency to depth, hydraulic load, and temperature, using an experimentally determined constant. The application of

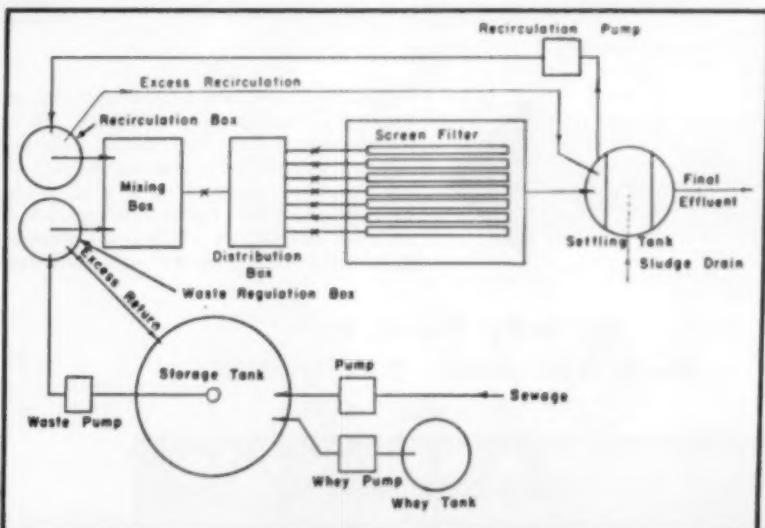
this equation to determine the effects of recirculation is discussed and the conformity between the adsorption process and the trickling filter process is pointed out.

"Load and Efficiency of Trickling Filter." By K. L. Schultze, Aast. Professor, Department of Civil Engineering, Michigan State University. *Jour. Water Pollution Control Federation*, March, 1960.

Ohio Turnpike Sewage Plants

In the planning and construction of the Ohio Turnpike 16 restaurant and service station areas were provided. At each location dual facilities were constructed on each side of the highway. However, each pair of restaurants and service stations are being served by common water and sewerage systems. In the design

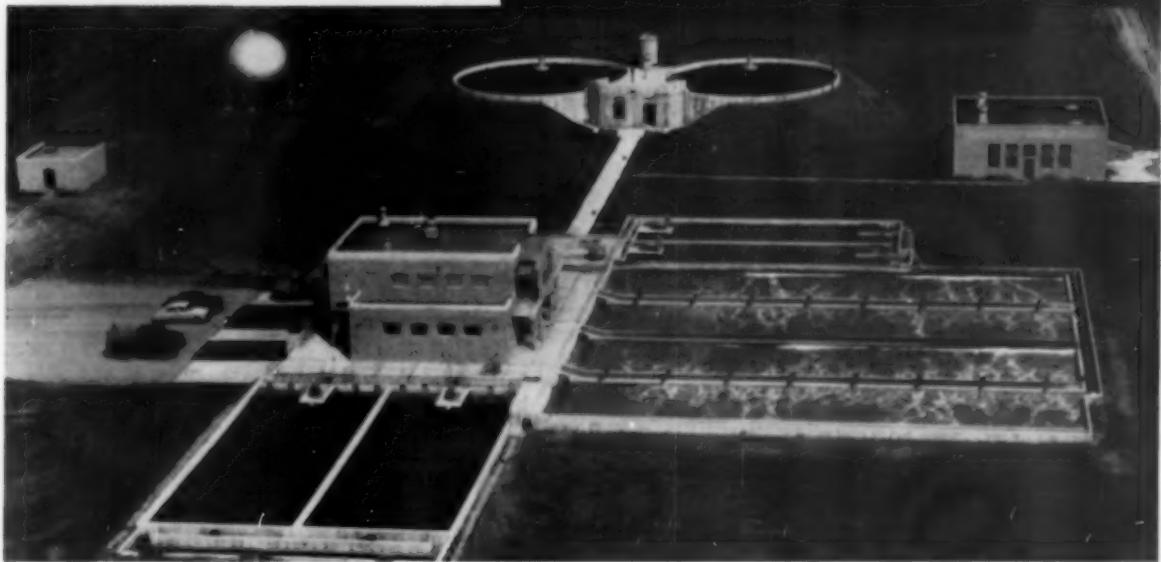
of these separate systems it was necessary to evaluate the experiences of the New Jersey and Pennsylvania Turnpike installations in order to overcome certain design and operating problems. For design purposes 100 gpm was selected as the average flow. Maximum average flows were assumed to be 175 percent of the average flow and peak flows were assumed to be 350 percent of the average flow. BOD concentrations of 500 mg/l, or more than 2 times that of normal sewage, were anticipated from these food handling and service areas. Grease and detergents were expected to be the most troublesome characteristics of the kitchen wastes. In determining the type of facilities to be installed, initial cost was important, but of even greater importance was obtaining a type of sewage treatment plant which could be



Courtesy Journal Water Pollution Control Fed.

● FLOW diagram of experimental trickling filter plant utilizing screen. Evidence appeared to indicate that loads to 11 lbs. of BOD per cubic yard could be handled.

P.F.T. DUAL DIGESTION



Modern Sewage Treatment at Connersville.

Embodying the following features, the Connersville, Indiana Sewage Treatment plant is serving the community efficiently and economically—

P.F.T. Dual Digestion. Not only do the two 65' P.F.T. Floating Cover Digesters receive the normal domestic wastes, but in addition, they receive garbage collected weekly from residential areas.

This highly volatile waste, after a grinding process, is pumped directly to the P.F.T. digesters.

Compactness. The Control Building is located in the center of the aeration and settling tanks and simplifies the control of plant operations. Expansion of the plant will be possible without disrupting operation because of this structural arrangement.

Equipment. Besides the two 65' P.F.T. Floating Covers, Connersville also has a #750 P.F.T. Heater and Heat Exchanger Unit, and P.F.T. Gas Safety Equipment.

Engineering. Garns and Moore and Associates, Inc., Indianapolis were the Consulting Engineers.



waste treatment equipment exclusively since 1893

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operated easily and with a minimum of expense. Three basic types of installations were considered. These were: 1) sand filters, 2) activated sludge, and 3) trickling filters. In addition, consideration was given to utilization of separate sludge digestion versus modified Imhoff tanks. Sand filters and activated sludge were discarded for several reasons and the conventional standard rate trickling filters were recognized as not being completely satisfactory. For this reason, two-stage filters were selected, with recirculation at a fixed rate. To solve the problem of grease and deter-

gents, a combination of sedimentation, with pre-digestion, and two-stage trickling filters, with recirculation, offered the rugged process necessary to handle the concentrated and complex sewage. This combination also offered simplicity in operation without the necessity of pre-treatment for grease removal. All plants have averaged removals of 98 percent BOD and 95 percent as.

"Sewage Treatment for Turnpike Service Areas." By Henry W. Hauenstein, Junior Partner, Finkbeiner, Pettis and Stout, Consulting Engineers, Toledo, Ohio. *Water & Sewage Works*, March, 1960.

How to Protect Concrete Sewers from Chemical Wastes

Chemical wastes have no
effect on concrete sewers when
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T-Lock Amer-Plate®

*(lining exaggerated in
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T-Lock Amer-Plate is a high polymer PVC sheet, easily cast into pipes, tunnels and structures to form a partial or complete 360° protective lining. Used in invert, it permanently protects concrete from corrosive chemical effluents. In arch areas, it positively stops oxidized H₂S corrosion. T-Lock is also highly abrasion resistant; impartial tests show that it abrades at only 1/70th the rate of concrete.

The fact that T-Lock ends erosion and corrosion problems in industrial and municipal sewer systems is attested to by more than five million square feet now in use. Write for complete data on this maintenance-saving lining before designing your next sewer.

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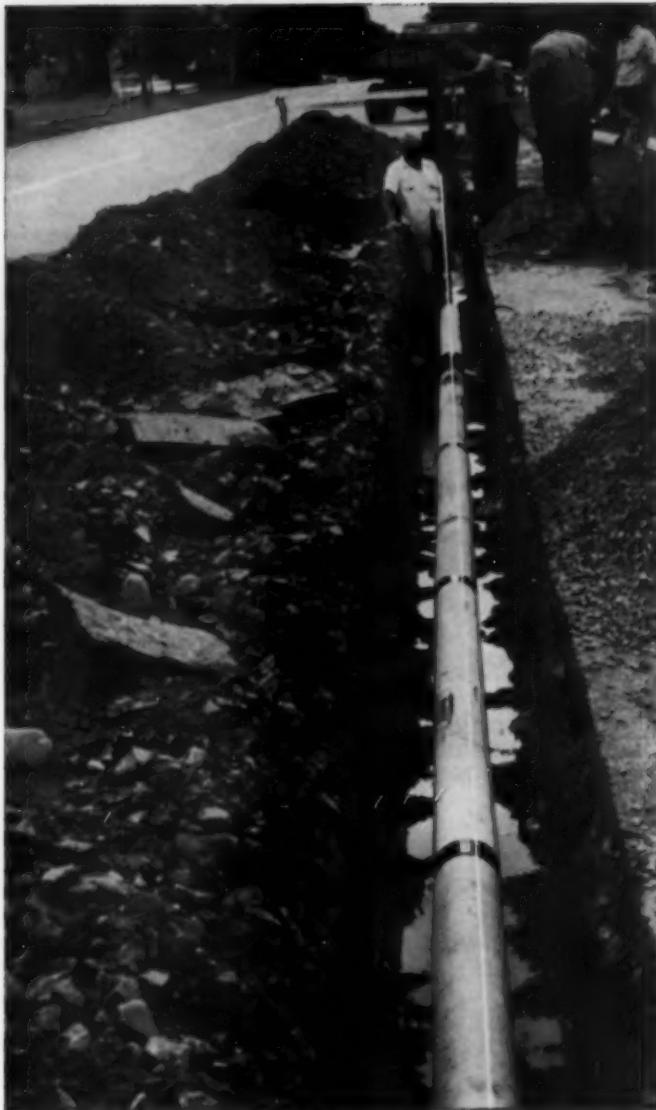
London's Newest Sewage Works

In 1959 the City of London completed the additions to the Northern Outfall Works consisting of an activated sludge plant of 60 mgd capacity, a digestion plant to digest all the sludge produced and a power plant for generating electricity and providing compressed air for the activated sludge process. The activated sludge plant consists of six aeration sets, each set having eight channels, 390 feet long, 16 feet wide by 14 feet deep, fitted with about 15,000 diffusers, 7 inches in diameter, for blowing air into the mixture of sewage and activated sludge. A total of about 70,000 cubic feet of free air per minute at 6 1/2 to 7 1/2 psi pressure is supplied. The sewage and activated sludge mixture then flows to the 110-foot diameter final settling tanks provided with Dorr sludge scrapers. The final effluent is discharged to the River Thames. The sludge is pumped to four dewatering tanks, each provided with thickener mechanisms, before transfer to the 16 sludge digestion tanks with a total capacity of 76,000 tons. After approximately 10 days' digestion in the primary tanks maintained at 85° F, the sludge flows to four secondary tanks for a period of further digestion to assist in the dewatering process and to reduce the volume for final disposal at sea some 35 miles from the Northern Outfall Works. This is the first installation in England in which the sludge gas has been used as fuel for gas turbines. The eight new gas turbines, powered by the sludge gas, provide a continuous flow of air to the diffused-air plant for the activation of the sewage and also provide a continuous supply of air for primary sludge digestion tanks.

"Sludge Gas Heats and Powers London's Newest Sewage Works." *Wastes Engineering*, March, 1960.

Sewerage Charges

Since June, 1959, Baltimore has had a new ordinance which levies a sewerage charge to cover the cost of operating and maintaining the sewerage system. This is considered to be the most equitable way of financing this municipal facility. The charge for sewerage service for each three months is 50 percent of the water bill, the property owner having to pay the bills in full, otherwise the city has the right to shut off the water until they are paid. The charges for sewerage service become a lien on the



SECTION THRU HOLES



The minimum crushing strengths* of Transite Underdrain Pipe for subsurface drainage systems are shown in the following table:

PIPE SIZE (inches)	TOTAL APPLIED LOAD PER LINEAL FT. (pounds)	PIPE LENGTH (feet)
6	1,000	10
8	1,000	10
10	1,100	13
12	1,200	13

*A.S.T.M. 3-edge bearing method
A complete line of fittings is available including elbows, tees, wyes, crosses, end caps and increasers.

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- Extremely good weight-strength ratio
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- Resists corrosion
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- Excellent alignment, tight joints, low material cost for new installation economies

For highways, airports, dams, industrial plant sites—anywhere there's a subsurface drainage job to be done—Johns-Manville Transite® Underdrain Pipe does it effectively and economically.

The plastic coupling used with Transite Underdrain Pipe assures a permanently tight, flexible joint . . . keeps out water-borne silt and maintains permanent pipe alignment. And, because of Transite's long (10 ft. and 13 ft.) lengths, fewer joints are needed in the line.

Made of tough, durable asbestos and cement, Transite Underdrain Pipe won't rust. Its interior is made smooth to stay smooth, assisting the flow of water and reducing the opportunity for solids to find a resting place in the line. As a result, the perforations are able to perform their function of permitting entry of ground water into the line, at a maximum rate, where it can be quickly carried off.

Transite's low material cost, installation and maintenance economies mean important savings from the time it is specified until there is no longer a need for the line. Let us send you, without obligation, our book TR-246A. Write Johns-Manville, Box 14 (PW-5), New York 16, N. Y.



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property of any person who fails to pay them. The charge for water during each three-month period is, as follows: For the first 5,000 cu. ft. of water 2.50 per 1,000 cu. ft.; for the next 45,000 cu. ft., \$1.50 per 1,000 cu. ft.; for over 50,000 cu. ft., \$1.00 per 1,000 cu. ft. The minimum charge for water for three months depends upon the size of the water meter, the minimum being \$2.50 for $\frac{3}{4}$ -in. meter and \$485 for a 12-in. meter, with the minimum sewerage charge being 50 percent of the water bill. In the 48 percent of the dwellings not pro-

vided with water meters, the charge for water depends upon the width of the dwelling, varying from \$10.00 per 3-month period for a dwelling with a width of 12 ft. or less, to \$48.75 for a dwelling with a width of 40 ft. or more. It was estimated that \$3,300,000 would be collected from the sewerage charges in 1959, providing approximately \$700,000 above the annual operating and maintenance expenses of \$2,000,000, for payment of interest and amortization on the outstanding sewer loans.

"Sewerage Charges Finance Sys-

tem Operations." By C. E. Keefer, Sewerage Engineer, and Rimmer Sklarevski, Assistant Mechanical Engineer, Bureau of Sewers, Baltimore, Md. PUBLIC WORKS, April, 1960.

Belle Glade's Sewerage Problems

Belle Glade's sewerage problems are probably the most difficult to solve of any in the State of Florida. Recently the City completed Phase I of the entire program which will eventually cost about \$1,600,000. This first phase included the laying of sewers; 27,140 feet of eight-inch, 1,700 feet of ten-inch, 745 feet of 12-inch, and 15,050 feet of six-inch vitrified clay pipe with factory-made joints. The water table being very near the surface in the Glades area made infiltration a major problem. In addition the flat terrain made it necessary to utilize a series of gravity sub-systems feeding into pump stations. Service to the entire city required 16 gravity subsystems, each serving an area of about 60 acres. The activated sludge treatment plant was constructed on piles driven to a depth of 30 feet. Sewage is brought to the plant through a 16-inch force main. The two primary sedimentation tanks are equipped with Link-Belt Straight-line sludge collectors. Aeration takes place in two tanks each equipped with four Chicago Pump swing diffusers. Foaming is prevented by means of spray nozzles. The effluent from the two final clarifiers is chlorinated. Two Fairbanks-Morse sludge pumps return the activated sludge to either the primary or aeration tanks. Sludge is pumped to a coverless digestion tank where recirculation is provided at 1150 gpm. Sludge is pumped to 16 drying beds. The present plant was designed to serve a population of 10,000, the anticipated population in ten years, at a cost of \$750,000.

"Belle Glade, Fla., Attacks A Difficult Sewerage Problem." By C. B. Talmadge, City Manager, American City, March, 1960.

Safety In Refuse Collection

Accident prevention or the promotion of safety is still not recognized as being of sufficient importance by too many municipalities for them to inaugurate or establish safety programs. This attitude can be attributed only to a lack of awareness of the costs. Many are hidden, some are intangible; but

IF YOU DON'T HAVE A TRUCK-LODER Your Sewer Crew is WORKING TOO HARD!

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LOADS DIRECT
INTO TRUCK

ENDS DUMPING
SEWERAGE
ON STREETS!

RELIEVES WORKERS
OF 3 HARD JOBS!

The TRUCK-LODER frees your workers from the hard jobs of manually dumping the bucket on the street — shoveling deposits into the truck, and cleaning up the street.

With the TRUCK-LODER two men can accomplish far more than four with conventional bucket machines, thereby freeing the extra men for other important sewer maintenance work.

Users report the elimination of time-consuming operations has increased sewer-cleaning capacity by 40%. They agree that TRUCK-LODER Bucket Machines exceed all performance estimates.

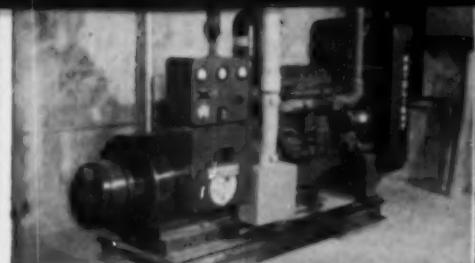
Your flexible representative will be glad to give you facts and figures at your convenience.

Use With Your Present Machines

Use Truck-Loaders on the dumping end and your regular machines on the Pull-In end. Net result—two complete, modern Truck-Loader units.

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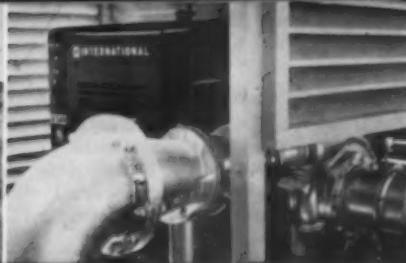
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International-powered standby generator provides emergency current for communications control center in Memphis, Tenn.



Secondary streets in Fort Worth, Texas are maintained by city's Galloway grader and Ingram roller, both with IH power.



Low-cost insurance for the water supply in downtown Stockton, Calif. is provided by International V-8 standby pump power.



The sewage plant at Los Altos, Calif. was carried safely through a dozen power failures by a dependable International engine.



In Tupelo, Miss., the Highway Department puts their handy IH-powered Gradall to work on a 2,000-ft. sewer line.

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Now, International design simplifies power installation. Your International Engine Distributor will help you with powering plans, and show you how the broad IH line can match the engine to the job. There's no underpowering or overpowering, and a variety of IH-built accessory equipment gives you options to meet all requirements.

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International dependability is a matter of record—power for graders, generators, crushers, pumps and other equipment—on every municipal application, public officials report continuous trouble-free performance under a variety of loads and operating conditions.

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There is no waiting for replacement parts. Your International Engine Distributor parts department is stocked to fill your parts needs immediately.

And his service shop and field service facilities are geared to keep your equipment operating at peak efficiency. Parts not in stock are available overnight from one of 12 International Harvester Parts Depots.

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taken together, the silent sabotage of accident losses adds up to a problem calling for the attention of top management. The author cites accident statistics from several cities, including that for the refuse collection services. The four circumstances in which most accidents take place are: 1) In driving and riding trucks (including circumstances where truck is moving and crew is on the ground); 2) in loading: a) getting, lifting and carrying containers; b) filling hopper or other loading action including mechanical loading cycle; 3) in un-

loading; and 4) in cleaning the vehicle. As in any other new project, the main essential is in organizing it—overcoming inertia and starting things moving. The main features in organizing a safety training program are these: 1) Put someone responsible in charge; 2) enlist the support of key officials; 3) train supervisors for their safety roles before proceeding with the training of other personnel; 4) consult all employees on safety needs; 5) the meeting place and the hour for the meeting must be carefully selected; 6) selection of good instructors; 7)

publicize the meetings; 8) follow-up the "skull" sessions with on-the-job supervision; 9) plan and operate the program in depth; 10) keep records; and 11) suggest feature news articles on the safety program. With the program for training outlined above, some respectable inroads can probably be made on accidents in any departments of refuse collection.

"Safety in Refuse Collection." By J. J. Carrell, Research Associate, Community Studies, Inc., Kansas City, Mo. PUBLIC WORKS, April, 1960.

Other Articles

"One Way to Get a Sewage Plant Built: Prohibit Further Sewer Extensions." Threat to growth of Wenatchee, Wash., causes city to build \$927,000 plant project when state agency imposed ban. By Chester E. Murray, City Engineer, City of Wenatchee, Washington. Wastes Engineering, March, 1960.

"Trickling Filter Theory." Hydraulic load and depth of filter are two of the major factors which determine efficiency in trickling filter operation. By K. L. Schulze, D. Sc., Dept. of Civil Engr., Mich. State Univ., East Lansing, Mich. Water & Sewage Works, March, 1960.

"New Equipment, Plants, and Installations." Part II of a pictorial review. Water & Sewage Works, March, 1960.

"Principles of Soil Engineering." Part III. Construction applications. By Robert F. Baker. Professor of Civil Engineering, Ohio State University. Public Works, April, 1960.

• • •

Hempstead Has Clean-Up Campaign

The Town of Hempstead, Nassau County, New York, through the Town Board, held its sixth annual clean-up campaign during April. For the purposes of the campaign, an attractive folder was prepared informing the residents of the program. The Township, which is the largest in the nation, was divided into four zones, and schedules were made up for each of the zones, starting one week apart. The program was concentrated on the collection and removal of large pieces of rubbish and of abnormal accumulations, with normal refuse collection services maintained meanwhile. Pickups were from the curb only and simple requirements for bundling and for containers were included in the folder. No charge was made for this clean-up collection work.

The descriptive material was sent us by Frederick W. Trautwein, Superintendent, Dept. of Sanitation, Box 26, Merrick, N. Y.

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A TYPE FOR EVERY SERVICE
RUGGED — DEPENDABLE

NON-CLOG SEWAGE PUMPS

**DRY PIT — WET PIT
SUBMERSIBLE
HORIZONTAL
CHOICE OF
IMPELLERS**



NON-CLOG DRY PIT pump with double suction elbow and stand. Send for Bulletin 1850.5.



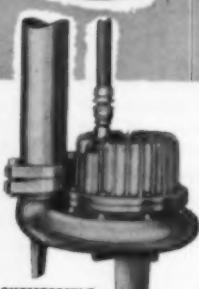
NON-CLOG WET PIT with cover. Single unit. Duplex models with alternating controls available. Send for Bulletin 1850.2.



PACIFIC NON-CLOG PUMP with motor, motor support bracket, suction elbow and stand. Send for Bulletin 1850.5.



HORIZONTAL NON-CLOG MODEL with flexible coupling. Send for Bulletin 1850.5.



SUBMERSIBLE NON-CLOG

A complete unit ready to install includes pump, motor, automatic controls and cable to control panel. Send for Bulletin 1850.5.

Outstanding performance and long trouble-free service from every type.

Pacific Non-Clog Sewage Pumps combine all desirable design features that assure efficient, economical and dependable operation and service.

Order now. ALL TYPES AVAILABLE FOR IMMEDIATE SHIPMENT.

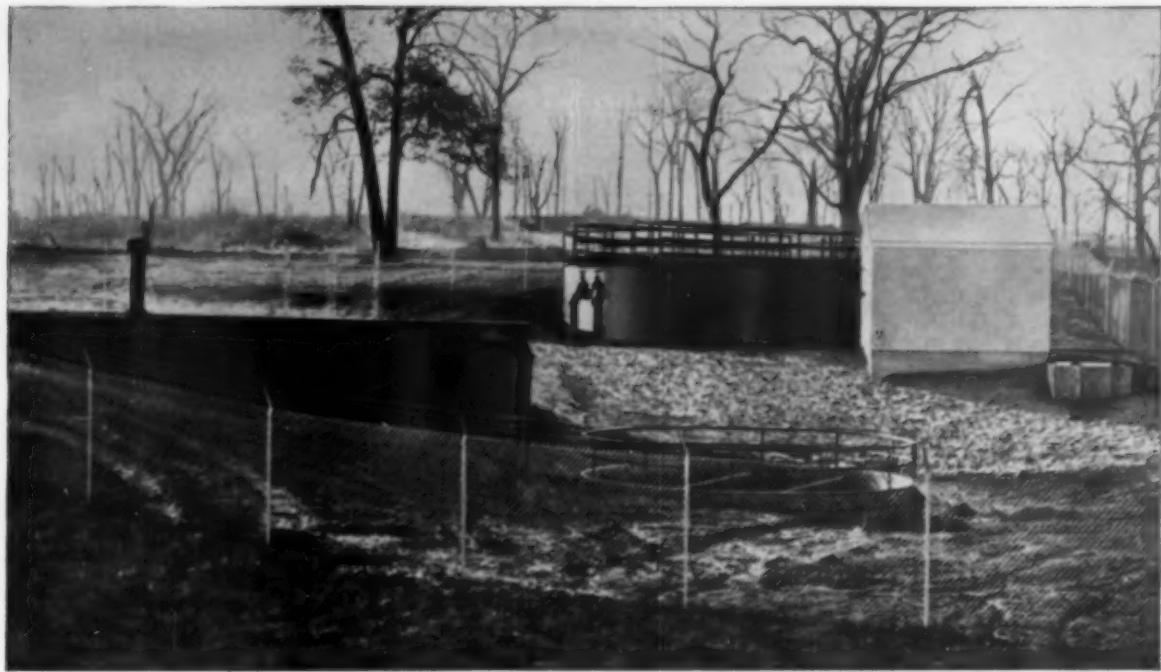
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How consulting engineers planned LOW-COST SEWAGE TREATMENT IN CRITICAL KANSAS CITY AREAS

Like many fast-growing metropolitan areas, Kansas City is faced with problems of satellite community sewage treatment. Yet, consulting engineers in the Kansas City area are solving these problems for their clients at a cost so realistic that engineers everywhere — faced with similar problems — should investigate.

A case in point is that of Gracemor Subdivision in Kansas City North, Mo. When this 700-home community was planned by Bolling-Hausmann Development Co., Consulting Engineers Raymond W. Campbell & Associates (Merriam, Kansas) were faced with finding a way to provide adequate sewage treatment within financial reason.

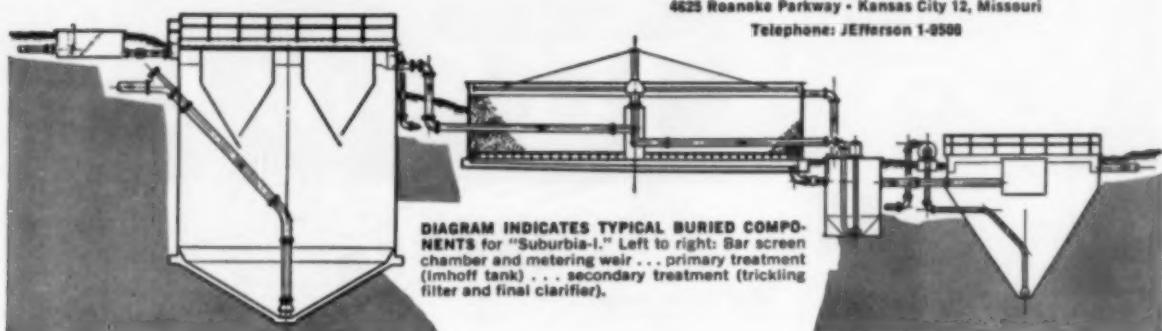
After study, Campbell & Associates suggested a "Suburbia" installation. The compact 245,000 GPD "Suburbia-I" (illustrated) now serves the citizens of Gracemor . . . and its cost was most real-

istic. This new type of installation provides conventional sewage treatment for communities of 200 to more than 10,000 homes. Because each installation is planned and installed under the direction of consulting engineers, "Suburbia" conforms to state and local Department of Health requirements.

"Suburbia" can be erected and enlarged for permanent use, or can be dismantled and re-erected elsewhere after eventual metropolitan hook-in. Its speed of erection (90-120 days) and simplicity of operation assure client satisfaction. Best of all, "Suburbia" involves less initial and operating capital than any other type of conventional sewage treatment plant. "Suburbia" is furnished and installed, on a turnkey basis only, by

MUNICIPAL SERVICE COMPANY

Your sewage service—our full responsibility
4625 Roanoke Parkway • Kansas City 12, Missouri
Telephone: JEFFerson 1-8500



New pressures
coming for

new treatment

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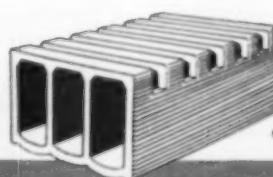
Three national magazines* in the first two months of 1960 have carried articles apt to alarm some fifty million readers about the possibilities and perils of polluted water supplies. More such stories can be expected to follow.

The Womans Clubs of America and the League of Women Voters are being alerted to them. The ensuing demands to clean up our waters by constructing sewage and waste treatment plants will rise far beyond the present experience of our engineers and public officials. (You get nowhere with telling women you cannot afford to provide what they consider their families' health and safety requires.)

* Readers' Digest, Good Housekeeping,
U. S. News & World Report.

WHAT TO DO . . .

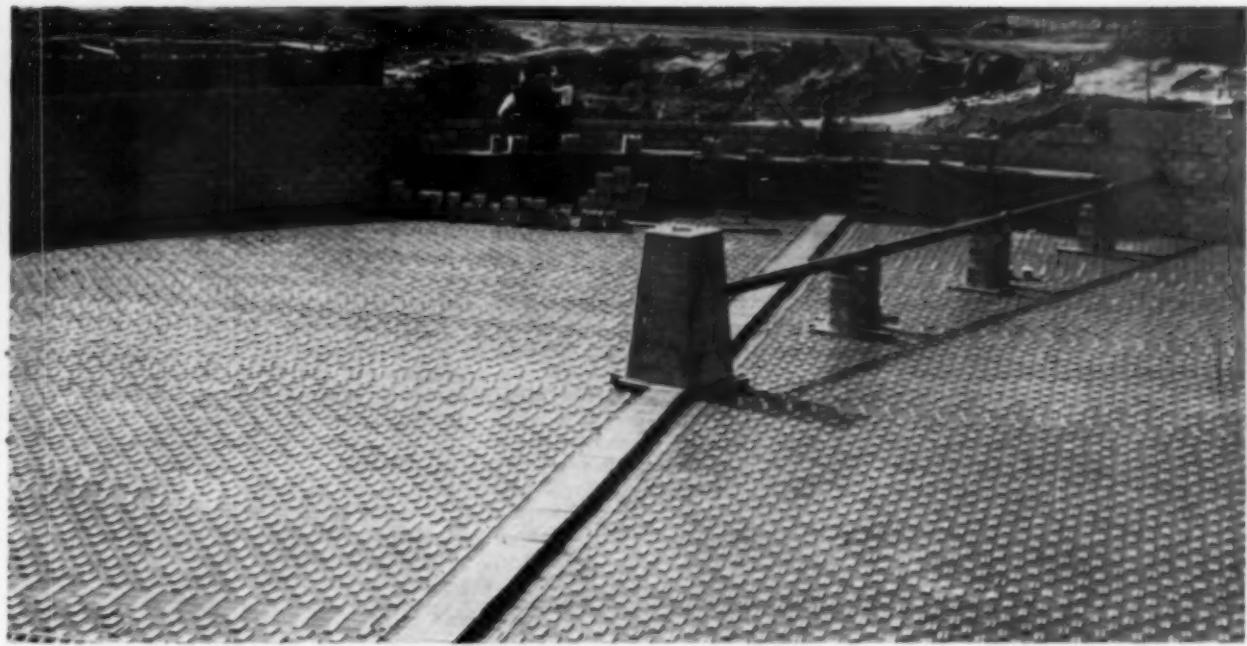
An answer for the average community that is reasonable in cost, high in efficiency and longest in life is Trickling Filters. The just-issued TFFI Trickling Filter Handbook, including the new ASTM Specifications C 159-59 T, gives full information on them. If you lack a copy just ask the nearest Institute member listed here for yours.



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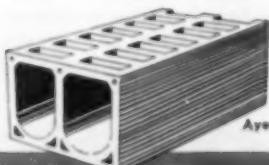
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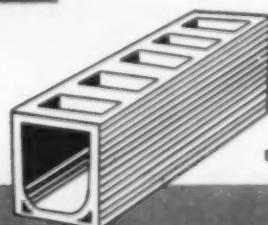
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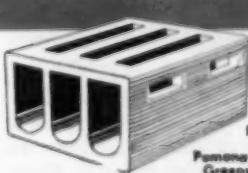


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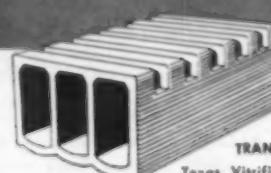
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DROUGHT FLOWS in New York State Rivers

In pollution control, the quantity of water flowing in a river is important and the flows during drought periods especially so. The Water Pollution Control Board of the New York State Department of Health, of which A. F. Dappert is Executive Secretary, undertook a study of this problem. On many rivers in the State flow gaging stations have been maintained for many years and records are available. For the study 55 streams in four major watersheds (Hudson, Susquehanna, Delaware and St. Lawrence-Great Lakes) were chosen.

The purpose of the study was to:

1) Present the cumulative frequency distributions of drought flows so that a low flow of any desired frequency could be determined directly; 2) determine which of three commonly employed mathematical distributions was most appropriate as a basis for future work; and 3) so generalize the findings for the major basins or geophysical areas as to permit an approximation of drought conditions on those streams for which meager or no flow records exist. The statistical analysis was conducted by the Civil Engineering Department of Manhattan College and was reported by D. J. O'Connor.

There are about 185 gaging stations on New York streams. While some records cover periods of more than 50 years, most of them extend over 15 to 35 years. A minimum record covering 30 years was considered desirable, and the majority of streams studied had records of 25 years or more. An attempt was made to obtain a uniform distribution throughout the state, but the greatest concentration of gaged streams were in the Southeastern portion and accordingly the majority of the selected streams were in that area. With very few exceptions, only those streams were studied which had no significant diversion or control that would interfere with normal low flow patterns. The final published records of the Geological Survey were used exclusively.

The average flow of a minimum consecutive seven-day period of each stream was tabulated for each year of record. This flow was calculated by dividing by seven the minimum sum of flows of a consecutive seven-day period. The values were tabulated in chronological order for each gaging station.

Statistical parameters were calculated by means of an automatic punch card machine. The first step consisted of key punching the basic drought flow data on cards. These data were then arranged in order of magnitude and converted to cubic feet per second per square mile by dividing by the drainage area tributary to the gauging station. The arithmetic average drought flow for each stream was determined and each flow was expressed as a ratio to the mean. The deviation from the mean, which has a value of unity, was calculated and the sums of the squared and cubed deviations were then determined. The sum of the deviations squared was divided by one less than the total number of items (years of record) and the square root taken to give the standard deviation. The skewness was calculated by dividing the sum of the deviations cubed by the product of twice the standard deviation and the sum of the deviations squared. In addition, the logarithms of the drought flows expressed as a ratio to the mean flow were key punched into a separate set of cards. The standard deviation was determined in the usual fashion employing the

MASS REMOVAL OF PALM LITTER

A CRANE and self-packing trailer unit, which were combined and put to work in Metropolitan Dade County, Florida, to begin a long-awaited rubbish removal program, has resulted in a labor-saving operation in which two men can do the work previously done by six. The unit consisting of a 35-cu. yd. Hobbs Hyd-Pak trailer and a mobile Daybrook Jib Boom was designed at the suggestion of Harris N. Buckner, Dade County Waste Division Chief. It requires only a driver, who doubles as crane operator, and one laborer to clean up. Controls for both the carrier and the crane are located in a single cab. The seat swivels to

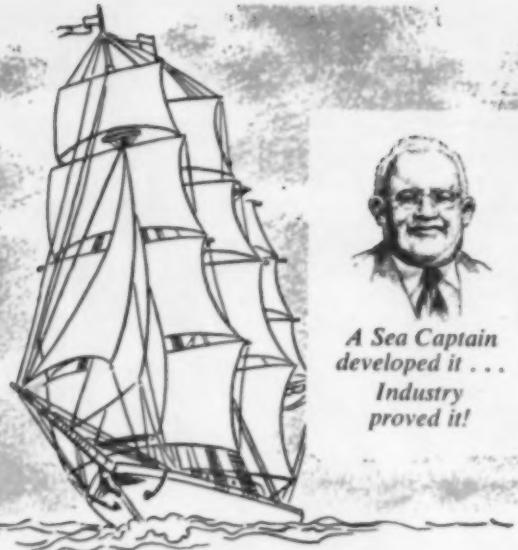
face either set of controls. When the trailer is filled, the blade moves the length of the trailer to expel the load through rear doors. The crane is equipped with a clamshell bucket that rotates 300 degrees to facilitate picking up the rubbish and to line up the load for the 9-foot hopper opening on the trailer. The county is contemplating the purchase of four more cranes and eight additional trailers as a start on a trash pickup program for the county. A shuttle system would be used so that when one trailer is filled another will take its place behind the crane. A \$6 per year trash pickup fee would be charged as soon as pickup begins in each area.



● CRANE-PACKER unit handles a big bite of tree trimmings and other rubbish in the rubbish removal program being tested by Metropolitan Dade County, Florida. The system uses a 35-yd. Hobbs Hyd-Pak trailer and a Daybrook Hydraulic Crane.

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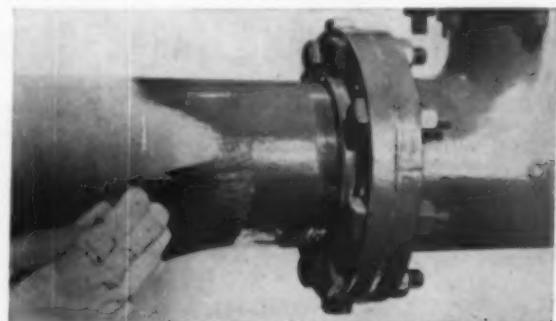
The original Rust-Oleum formula was developed nearly fifty years ago by Sea Captain Robert Fergusson, who became intrigued with the rust-stopping qualities of fish oil early in his career. Creating a special treatment for the fish oil, he used the specially-processed fish oil as the vehicle in combination with fine rust-inhibiting pigments. The result? A coating that actually stopped rust when applied directly over sound rusted surfaces, after scraping and wirebrushing to remove rust scale and loose rust. Possible, because the specially-processed fish oil penetrated the rust to bare metal. This was the birth of Rust-Oleum's exclusive 769 Damp-Proof Red Primer.

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logarithms instead of the actual values.

Statistical analyses were employed to estimate, on the basis of past records, the probability of occurrence of future low flows. This consisted in developing a curve indicating the relationship between the probability of occurrence and the magnitude of the drought flows. The mathematical procedures followed, including use of the logarithmic normal, the Pearson Type III and the Gumbel curves are reported in Research Report No. 1, Statistical Analysis of Drought Flows in Rivers of New York State, published by the Board.

In the Hudson River Basin, studies were made on 17 streams. Some of these are reported below, with drainage area and minimum 7-day flow in cubic feet per second per square mile (cfs/sm).

Poesten Kill, 89 sq. mi., 0.267 cfs/sm; Catskill Creek, 98 sq. mi., 0.267 cfs/sm; Hudson River above Newcomb, 192 sq. mi., 0.237 cfs/sm; Wallkill River above Pellets Is., 385 sq. mi., 0.128 cfs/sm; Hoosic River above Eagle Bridge, 510 sq. mi., 0.321 cfs/sm; Mohawk River above Little Falls, 1348 sq. mi., 0.586 cfs/sm; Hudson River above Mechanicville, 4500 sq. mi., 0.452 cfs/sm.

In the Delaware River basin, studies were made on 13 streams, including the following: Little Beaverkill above Livingston Manor, 20 sq. mi., 0.206 cfs/sm; Willowemoc above Livingston Manor, 63 sq. mi., 0.318 cfs/sm; Little Delaware above Delhi, 50 sq. mi., 0.266 cfs/sm; Beaverkill above Cooks Falls, 241 sq. mi., 0.289 cfs/sm; West Branch of the Delaware, 593 sq. mi., 0.147 cfs/sm; East Branch of the Delaware above Fish's Eddy, 783 sq. mi., 0.226 cfs/sm.

In the Susquehanna River basin, 13 streams were studied, including: Tioga River above Lindley, 770 sq. mi., 0.057 cfs/sm; Owego Creek above Owego, 186 sq. mi., 0.083 cfs/sm; Chenango River above Greene, 598 sq. mi., 0.156 cfs/sm; Unadilla River above Rockdale, 518 sq. mi., 0.151 cfs/sm; Susquehanna River above Conklin, 2240 sq. mi., 0.161 cfs/sm, and above Vestal, 3960 sq. mi., 0.152 cfs/sm.

In the St. Lawrence River basin 11 streams were studied including: Salmon River above Chasm Falls, 132 sq. mi., 0.651 cfs/sm; St. Regis River above Brasher Center, 616 sq. mi., 0.355 cfs/sm; Genesee River above Scio, 309 sq. mi., 0.089 cfs/sm, above Rochester, 2,467 sq. mi., 0.290 cfs/sm, and above Oswego, (Please turn to page 212)



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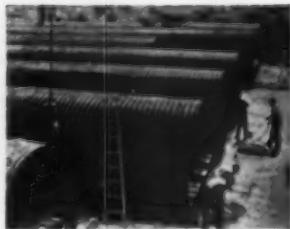
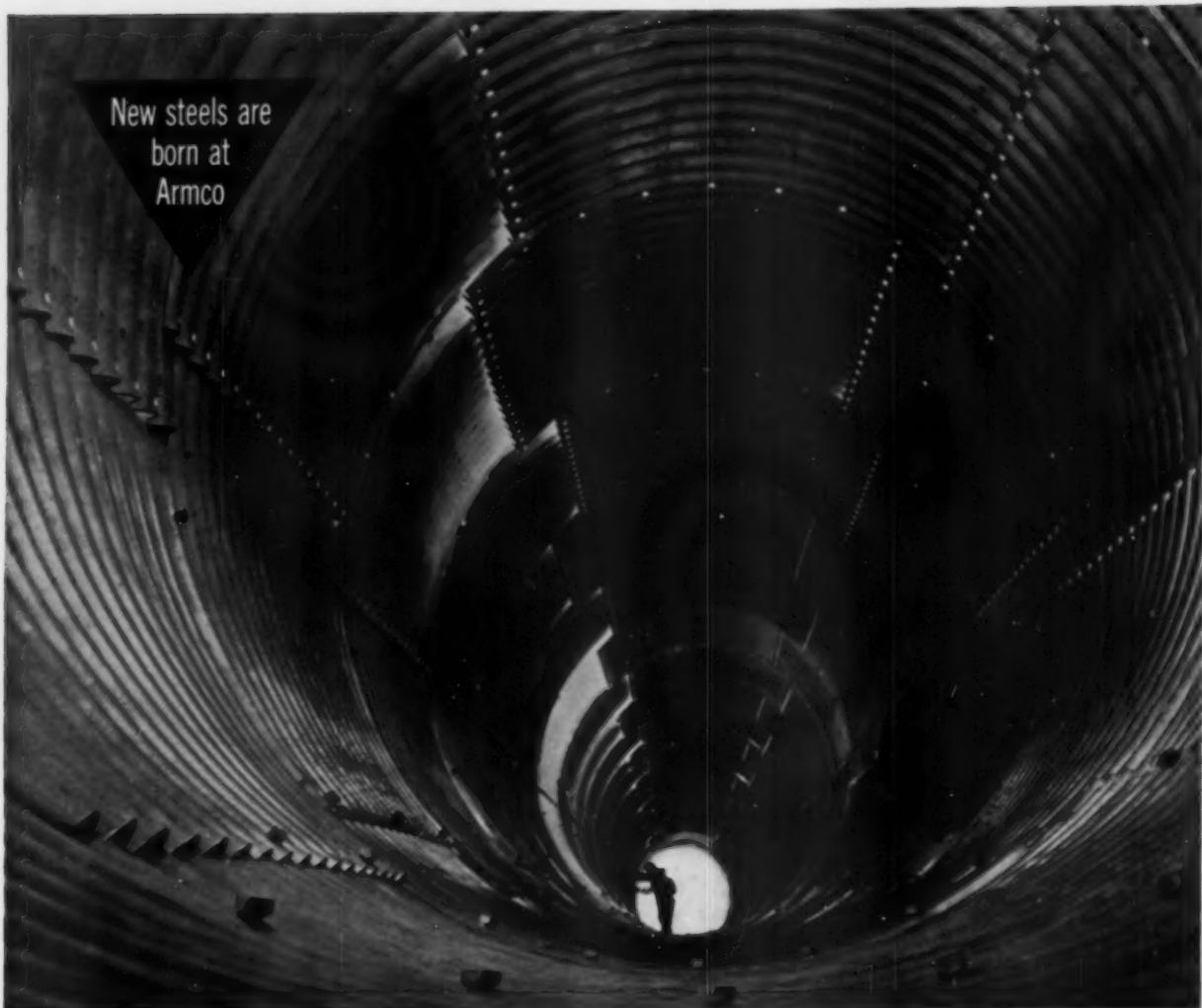
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MERTZTOWN, PENNSYLVANIA

5,124 sq. mi., 0.216 cfs/sm; Racquette River above Piercfield, 722 sq. mi., 0.354 cfs/sm.

For purposes of comparison, the Allegheny River above Redhouse has a drainage area of 1690 sq. mi., and a minimum 7-day flow of 0.105 cfs/sm.

For each of the 55 streams a drought flow analysis chart has been prepared and these are published in the report. Sample calculations are shown for the Chenango River at Greene using Logarithmic normal, Gumbel and Pearson Type III methods.

Downtown Bloomington—1984

URBAN sprawl and dispersion are affecting central business districts in many cities. Though as yet little affected, Bloomington, Ill., in order to meet problems that might arise, undertook an imaginative program. Under the leadership of Mayor Bob McGraw and City Manager Eugene G. Moody, a study was instituted with the cooperation of the Graduate School of Architecture of the University of Illinois.

Professor Richard A. Williams of the University served as coordinator and director of the study and utilized eight graduate students of architecture for an entire semester on this project. The project involved a study of existing land and building uses in the downtown area of Bloomington and a study as to the optimum uses of this portion of the community twenty-five years from now. Each of the eight students worked for about a month from the basic data in the City Plan and from

his own studies, and presented a 3 x 3 scale model of his proposal.

Mayor McGraw, City Manager Moody and several local architects then served as a panel of judges to select the best basic plan. Following this selection, all of the eight students cooperated in refining and redeveloping this proposal into a large 8 x 8 scale model. The model and proposals by students were presented in February to a mass public meeting at the Illinois Wesleyan University Student Union Building, Bloomington, and the discussions which this presentation stimulated are still evident in the community.

The Association of Commerce has appointed a committee to investigate the future of redevelopment of the downtown area. The City Planning Commission has initiated studies to evaluate the coordination of the new thought with the existing street patterns as depicted in the master plan of the city.



• SCALE MODEL of the central business district redevelopment project is examined by Professor Richard A. Williams, Bloomington's City Manager Eugene G. Moody, Mayor Bob McGraw and Lon Sargent, Director of the Illinois Municipal League.

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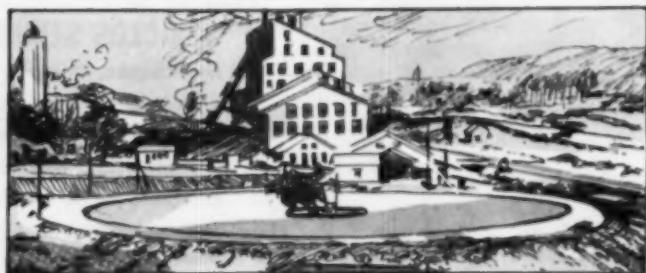
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THE
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DIGEST**



Prepared by CLAYTON H. BILLINGS, Associate Editor

**Tracing Radioactive
Pollutants**

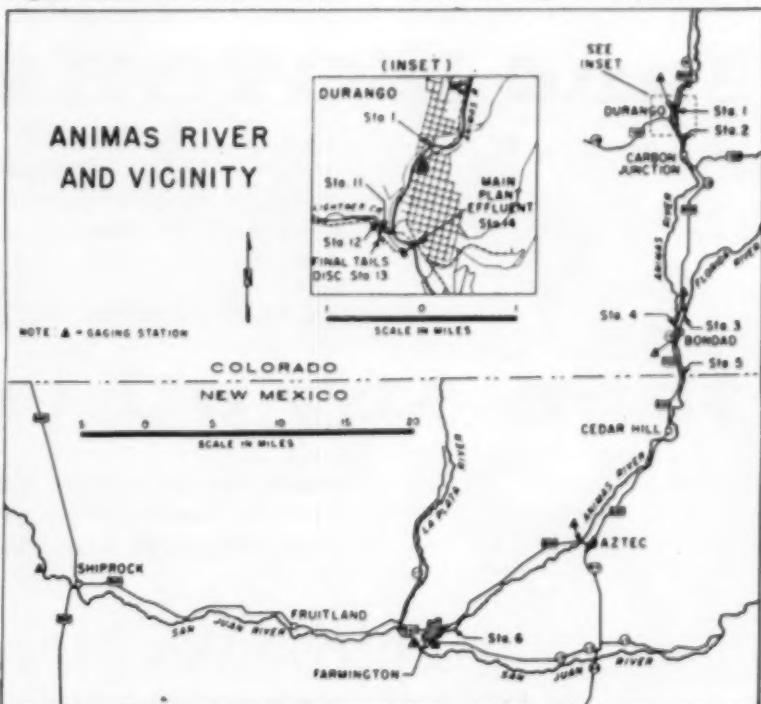
A comprehensive survey was made by the Public Health Service's Division of Water Supply and Water Pollution Control to determine the effect of discharge of uranium ore refining wastes into the Animas River. The refining operations take place at Durango, Colo. The Animas River is used as a source of water supply for Aztec and Farmington, New Mexico; for irrigation of 62,000 acres in both states; for rural domestic water supplies without treatment; and for recreation. The survey included studying the mill processes and sampling water plants, dairies and various points on the river. River samples were analyzed for alpha and beta radioactivity and dissolved radium. The quantity of dissolved radium found at a point a short distance downstream from the mill could not be accounted for by the radium releases from the mill. Mud sample analyses revealed that the bottom deposits acted as radium reservoirs and could be expected to contribute to the radium content of the water with ascendancy of river flow. Also alpha activity was found to accumulate in aquatic biota. Sampling at the Aztec and Farmington water plants revealed that the plants, which used conventional coagulation and filtration, did not remove dissolved radium. The radium content of foods grown downstream was nearly double that of foods from above the mill. The findings were presented at a conference of representatives of the Public Health Service, of the uranium company and of the two state health departments. It was agreed that the company would install treatment facilities to remove all settleable solids, to reduce radium in the effluent by 70 percent and to reduce toxic materials in the effluent.

"Control of Radioactive Pollution of the Animas River." By E. C. Service. *Journal Water Pollution Control*, Division of Water Supply and Pollution Control, Public Health Service, *Journal Water Pollution Control Federation*, March, 1960.

**Sewers and
Tannery Wastes**

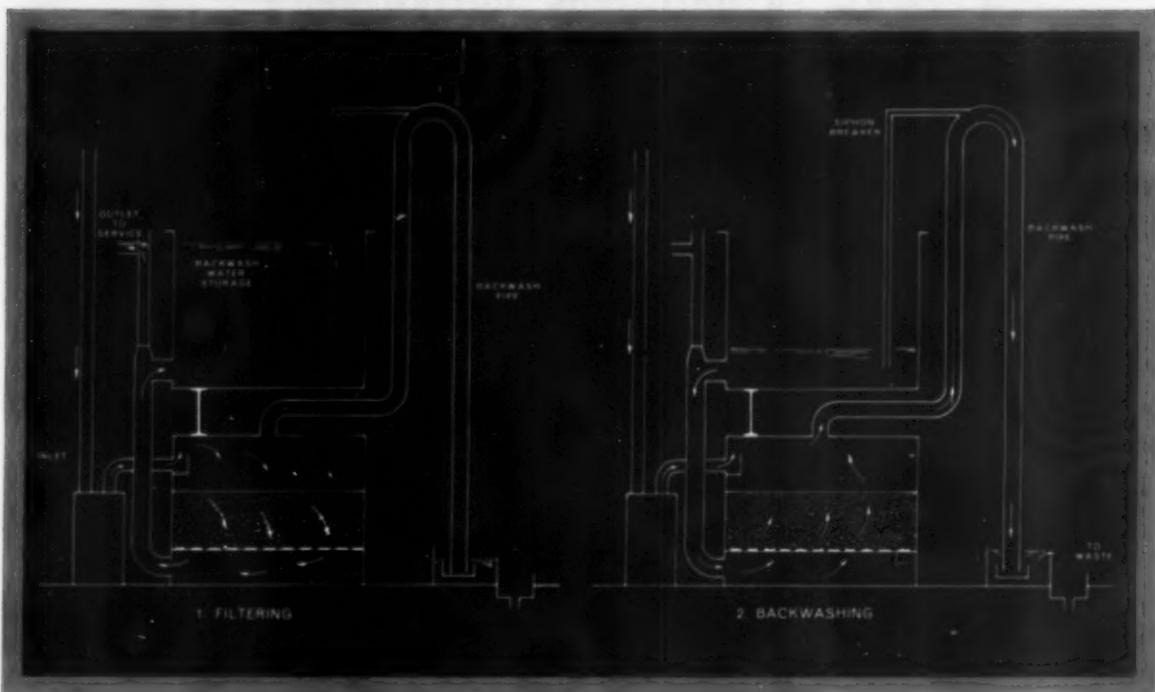
Prior to accepting wastes from a large tannery in 1951, the South Essex Sewerage District in Danvers, Mass., specified limitations on the content of caustic lime at 75 ppm; on grease, 300 ppm; and on suspended solids, 500 ppm. Despite this regulation severe calcium incrusta-

tions of trunk mains occurred, necessitating re-evaluation. Samples were collected at the tannery and from sewers above and below the points of discharge. It was found that the beamhouse wastes contained an average of 1,670 ppm caustic alkalinity, equivalent to 940 ppm caustic lime. The results also indicated that when the wastes were mixed with sewage, the introduction of carbonate ion caused the solubility product of calcium carbonate to be exceeded, a potential cause of deposition. Experiments showed that carbonation of the tannery waste to a pH of 9.0 or lower (from the original 11.9) resulted in



● MAP SHOWS the Animas River area where a comprehensive study was made to determine a practical approach to a rational control of radioactive water pollutants.

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removal of most of the calcium and metal ions present and materially eliminated the scale forming tendencies of the waste.

"High - Lime Tannery Wastes Cause Sewer Incrustation." By A. C. Bolde, Massachusetts Dept. of Public Health and B. L. Rosenthal, Lawrence Experiment Station. *Wastes Engineering*, March, 1960.

Industrial Waste Stabilization Ponds

Faced with the problem of having to dispose of the wastes from

six different food producers, the City of Grandview, Wash., constructed three small oxidation ponds for treatment. They were first operated without control of loadings, resulting in complaints about odors. Washington State University, Sanitary Engineering Section, requested permission to operate the ponds under the supervision of the City's consulting engineer. The wastes were from canneries, grape juice bottling plants and a winery. The ponds were connected in series. A Parshall flume was installed to permit flow regulation and measure-

ment, and the first pond inlet structure was changed to discharge at a central location. Irrigation water was turned into the ponds to fill them. Then the waste was admitted for 8 hours per day. However, a minimum flow of irrigation water or waste was maintained to assure a flow out of the third pond. Loading was varied experimentally. It was concluded that ponds used for seasonal organic wastes can be designed for loadings of 100 lbs. per acre per day; more waste can be handled by a single pond or several ponds in parallel than by ponds in series; series operation appears justified only for shock loads; and greater loading could be handled by allowing the first pond of a series to be anaerobic and the second to be aerobic. The anaerobic pond would produce odors and could be used only in certain locations.

"Experimental Operation of Industrial Waste Stabilization Ponds." By Gilbert H. Dunstan and Leonard L. Smith, Washington State University. *PUBLIC WORKS*, April, 1960.

Total Oxidation of Ice Cream Wastes

The wastes from the A. R. Parker Co. restaurant-ice cream plant in Bridgewater, Mass., were formerly treated by a septic tank and discharged to an open ditch. This led to complaints and Rolf Eliassen Associates were engaged to determine a means of correction. The wastes consisted of washings from the restaurant and ice cream manufacture and domestic sewage. In the summer ice cream is made 3 or 4 times per week and once per week in winter. A new plant was designed using the complete mixing principle of the activated sludge process. It consists of a single reinforced concrete tank, divided by a steel baffle into aeration and settling compartments. The aeration portion has a 35-hour retention period based on an average flow of 8700 gallons per 19 hours. Air was supplied by a 90 cfm, 5 psi Spencer Turbine. Later, peak loads were encountered, much higher than were anticipated, causing release of solids in the effluent and septic conditions were observed in the sedimentation section. The solution was removal of a deflection baffle originally placed in the sedimentation section to improve air lift return of sludge. It was found that some turbulence must be permitted in this section to keep the sludge in suspension about one foot below the surface. Operation is essentially

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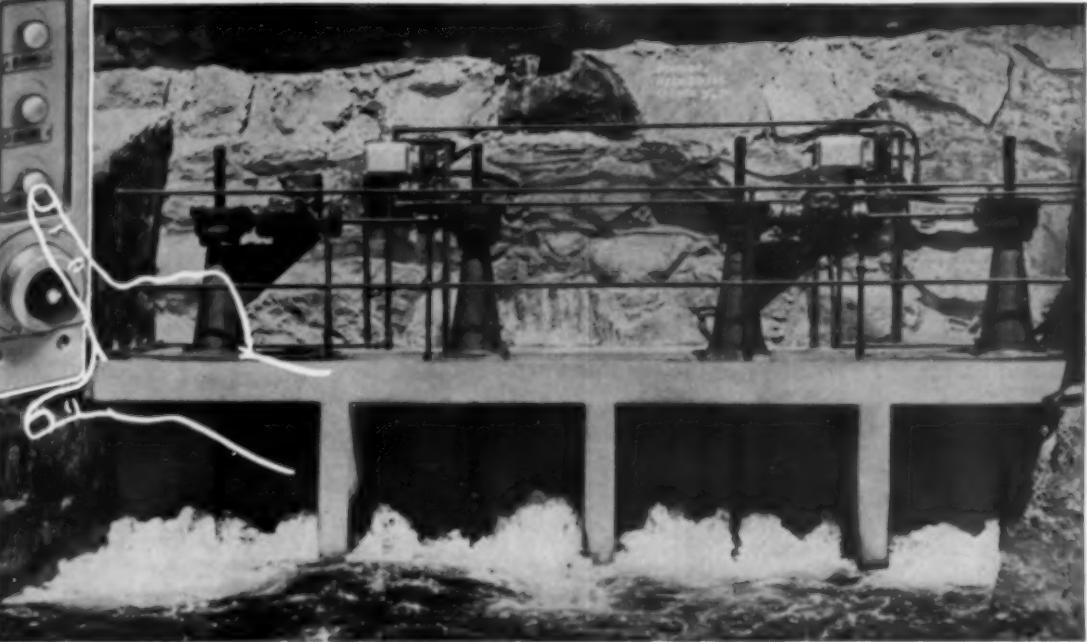
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"Waste Treatment for an Ice Cream Plant and Restaurant." By R. E. McKinney and Donald Schwinn, Massachusetts Institute of Technology. PUBLIC WORKS, April.

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"Review of Detergent Research Program." By P. J. Weaver, Procter and Gamble Co. Journal Water Pollution Control Federation, Mar., 1960.

Other Articles

"Treating Sewage Containing Brewery Waste." By M. A. Tidwell. At Burton-upon-Trent, England, 70 percent of the community waste flow is from a brewery. A pilot plant was constructed to obtain design bases for a treatment plant. "Contractors Record and Municipal Engineering," March 2, 1960.

"Oxidation Is the Best Method of Deodorizing Polluted Air." By W. Summers. Ultra violet radiation is used to deodorize air in sewage pumping stations. The generators are suspended from the ceiling to irradiate air overlying the stream of sewage. Municipal Engineering, February 26, 1960.

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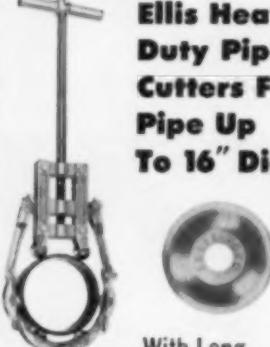
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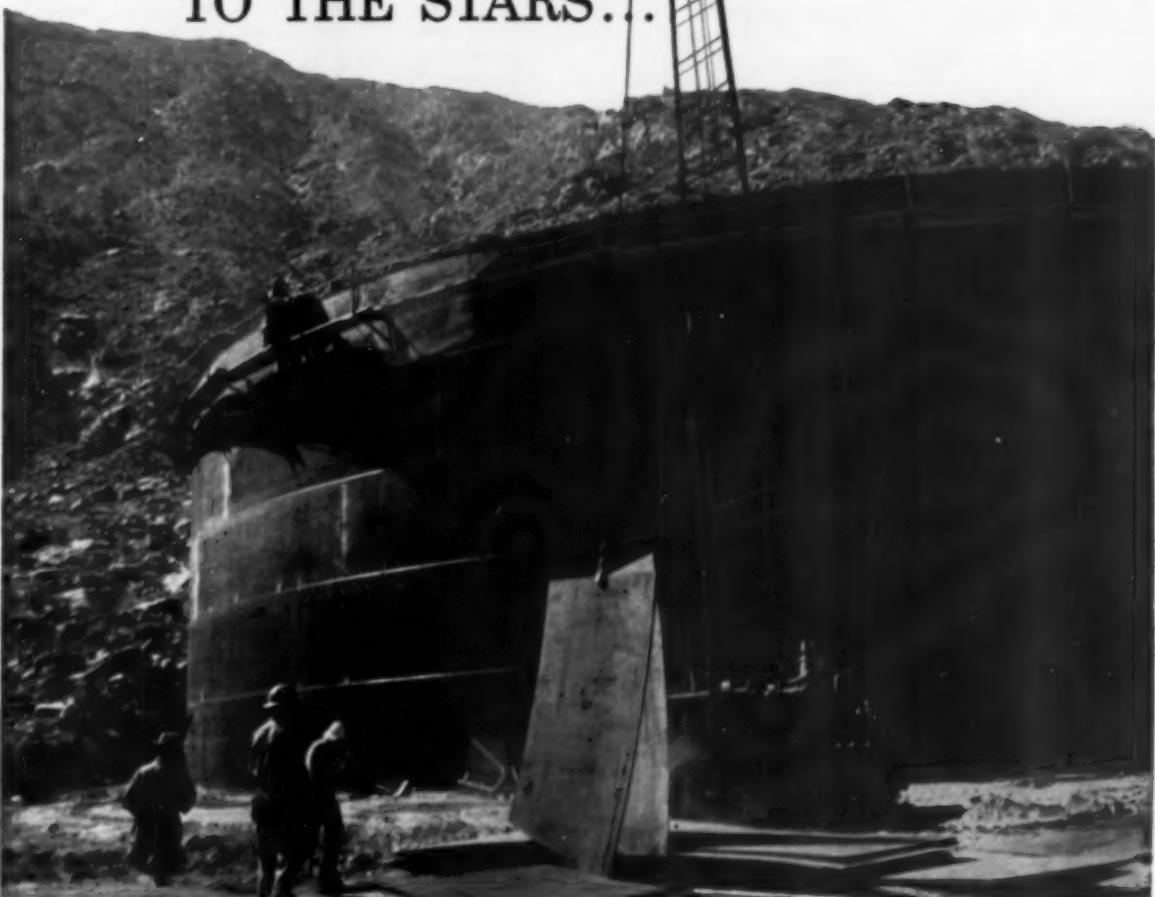
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ABSTRACT OF ESSENTIAL TESTIMONY IN A SUIT AGAINST OPERATION OF A SEWAGE LAGOON

THE CITY of East Grand Forks, Minn., proposed to construct a lagoon for the treatment of its sewage. A group of farmers living near the site of the proposed lagoon formed a "Public Service Committee" and attempted to prevent construction. State law provides that a bond equal to the cost of the improvement, which was approximately \$250,000, must be posted in order to delay construction. The farmer group was unable to post such a bond. However, after completion of construction, the judge allowed the farmers to sue to prevent operation of the lagoon system.

The case was tried without a jury and solely before the judge. The case was decided against the farmers on the basis of testimony by various witnesses that it did not constitute a health menace. The

actual testimony in the case amounts to 800 pages. This bulky testimony has been condensed by R. L. Smith and H. C. Leibee, consulting engineers of St. Paul, to highlight the more important points brought out in the suit. Furthermore, the editors have attempted to brief the experience background and some of the factual statements of the various expert witnesses further to reduce space.

Donald L. Floan, City Engineer of East Grand Forks, a graduate, civil engineer, stated that there were four farm houses within a half mile distance of the pond. He further stated that he has hunted ducks on other raw sewage ponds.

Microbiologist Testifies

Dr. H. Orin Halvorson, microbiologist, of the University of Illinois, consultant for a number of

years to the Army, Navy and Public Health Service, testified. Portions of his testimony follow:

Q. Is it possible in a raw sewage pond, after the sewage is discharged into the pond to treat that sewage chemically or otherwise?

A. It's not normally done and it would be rather awkward to do that.

Q. If you treated it would you spoil the effect of the natural processes?

A. If you have reference to treating it with a germicide such as chlorine, that would interfere with the natural process that goes on.

Q. Now, Doctor, you were in court this morning and heard Mr. Floan testify, were you not?

A. Yes.

Q. You heard him testify that in their sewage ponds contemplated



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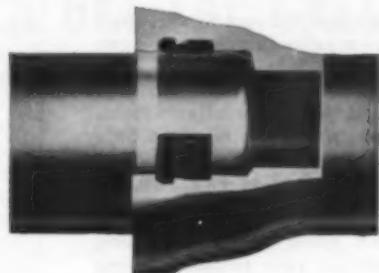
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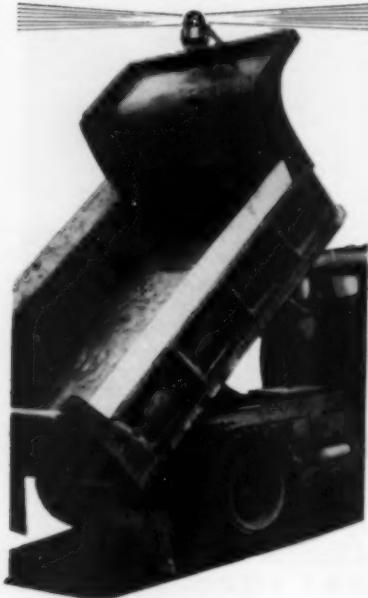
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for East Grand Forks there would be no treatment of the raw sewage before it was discharged into the lagoon or pond itself and that the raw sewage would contain human excrement. Does human excrement contain disease germs or organisms?

A. It does, yes.

Q. What type does it contain, are there several different types, doctor?

A. Well, the human sewage may contain a variety of disease producing organisms. We generally call them pathogens, they may be of animal origin like the protozoa.

Q. The protozoa, doctor?

A. Yes, the single-celled animals, of plant origin like the bacteria, or viruses.

Q. Are all these types of pathogens common in human excrement or human sewage?

A. You must presume that they can be present in sewage, they would be discharged into sewage by persons who are either suffering from the disease or persons who are healthy carriers of that disease.

Q. You have mentioned this protozoa, now, doctor, do you off-hand recall any diseases that might be from pathogenic protozoa?

A. A common one would be amebic dysentery which is caused by pathogenic protozoa.

Q. When you speak of pathogenic bacteria, doctor, what diseases would be included in that category?

A. There are a group of diseases which are caused by organisms that have as a portal of entry the digestive tract, and are generally discharged through fecal discharges. To name some examples, typhoid fever, paratyphoid fever, bacillary dysentery and there are a number of not too well defined intestinal disturbances which can be caused by bacteria which produces their primary effect in the intestines and would be discharged through the stool.

Q. What about tuberculosis, doctor?

A. Tuberculosis could also be found in sewage; that does not normally infect the intestinal tract but affects the lungs particularly, and the respiratory system . . .

Q. What type of diseases might be represented by pathogenic viruses?

A. There are a number of diseases caused by viruses, the ones most familiar to the layman would probably be poliomyelitis, encephalitis or what is commonly called sleeping

sickness, the common cold and influenza—there are a rather large number of diseases caused by viruses—a number of them may be classified as the interior viruses, viruses found in the discharges and organisms that probably grow in the intestinal tract.

Q. Can pathogenic protozoa exist and live in a raw sewage pond?

A. Yes, they would; particularly the encysted form (a sort of resting stage of its growth) could live for quite a long period of time.

Q. When you say quite a long period of time, doctor, I wonder if you could tell us what you mean by that.

A. I'm not referring to minutes, I am referring to hours, days or weeks.

Q. In a raw sewage pond too, doctor, could pathogenic bacteria exist and survive?

A. Yes, they are known to have a fairly long life span in such environment, they may not multiply particularly but they may not die off very fast either so that the organisms could presume to be isolated from the effluent coming from a sewage treatment plant and presumably the effluent that comes from a sewage lagoon.

Q. And, doctor, pathogenic viruses . . .

A. Viruses, some of them are fairly resistant and probably can live a dormant life, some of them much longer than bacteria even. Here again it is an area that requires much more study because it is only very recently that we have been able to cultivate many of these viruses and to study many of their properties.

Q. If they were discharged into a raw sewage pond such as we have been discussing today how might they be spread?

A. Well, there are a number of ways that can be done, one would be by mosquitoes that can carry the agents in which the mosquito serves as a stage in the life cycle of the organism. I suppose a good example would be the virus that causes encephalitis or sleeping sickness. This virus can be carried by a mosquito and the mosquitoes could be infected by the organism and thus be carried to people. Insects could carry the pathogenic organisms as mechanical carriers by contaminating their bodies and lighting on other areas contaminating the area on which they light—in this mos-

quitoes could also play a part. Infection could occur through migratory fowl that settle into the pond and then fly elsewhere or fowl that are hunted and shot and persons who handle them might be in danger of contamination. They could be spread by household, domesticated pets that might come in contact with the water and be contaminated and carry the organisms elsewhere. And they could be spread by rodents that come in contact with the water and also they could be spread by what is now referred to as aerosols, sprays that could be brought into the air through strong wind action and the organisms could be carried on these sprays. Of course, the water itself would be a hazard to people that come in contact with it; in other words, a person shouldn't drink it. If they contacted it they could contaminate their hands and so forth and so that direct contact with the water by people should be avoided.

Testimony of Physician

Another witness was Newall R. Ziegler, MD and Ph. D., a doctor and microbiologist, who had taught bacteriology and preventive medicine at the University of Missouri, served in an army medical diagnostic laboratory during the war and returned to the faculty of the University of Minnesota. Pertinent portions of his testimony follow:

Q. Now, doctor, from your experience in bacteriology I will ask you this question: where you have human sewage or human discharge run through a sewer system without treatment and discharged into a raw sewage pond that we have been talking about today do you have what is called protozoic bacteria and virus in that human discharge?

A. These are commonly present, yes, sir, at least they may be, depending on whether the humans contributing had these particular organisms and usually in a population of any size you have this wide variety of microorganisms present.

Q. Where you have a city of the size of Grand Forks or of East Grand Forks . . .

A. On the average you would expect to find this wide variety of organisms, yes, sir.

Q. Doctor, I would like, I know some of this is covering the same ground as we did with Dr. Halverson, but I wonder if you would explain to the court also what are the usual and normal types of pathogenic protozoa that you might find



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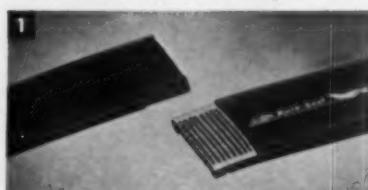
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in human waste and human discharges.

A. I suppose the most commonly found protozoa would be the organism causing amebic dysentery.

Q. Might I ask you the same question about pathogenic bacteria?

A. There are a variety of pathogenic bacteria that may be present in sewage or in human intestinal contents, depending upon whether the individual is a carrier of that particular organism, whether he is just recovered from a disease caused by that kind of organism as in the case of typhoid fever, or the dysentery group of organisms—bacillary dysentery of which there is a considerable number; usually these are not carriers but they are present in such large numbers at times in the intestinal content that they exceed the coliform index which we usually like to use as indicating the sewage pollution. You may find, too—even aside from the reasons mentioned by an earlier witness—there may be ulceration of the intestinal tract where the organisms are actually being sloughed out in large numbers. The paratyphoids are also quite often present in variable numbers, either as carriers, with the individual being a carrier or actually having an infection from this type of organism.

Q. What type of pathogenic virus would you generally find?

A. You would expect at least initially to find the pathogenic viruses that have been found in the intestinal tract of man, including that of poliomyelitis—it's actually been found to grow on sections of intestines of monkeys, for instance or imbedded in the tissue in man. The hepatitis virus is believed to leave the body in the intestinal content. That is derived from the liver excretions or secretions of the liver and the bile so that it would be a logical exit for this virus. The virus of encephalitis conceivably would pass through the intestinal tract and a large group of viruses which have been largely lumped as the enteric viruses causing a variety of symptoms, sometimes members of this group may be involved in epidemics of infantile diarrhea in hospitals or in some instances—at least it has been suggested—that they were derived from contaminated water supplies.

Q. Doctor, in your opinion, how long will these various pathogens or these protozoa or bacteria or viruses live in a raw sewage pond

such as has been described here today?

A. I think the survival is dependent upon a lot of conditions, including temperature, the number of bacteria of a type deposited in such an area, volume at any one time, upon the natural destructive action of various agencies, wave action, you might include one of the natural destructive agencies a virus type which destroys some types of bacteria and this is quite a variable mechanism, but when we speak of this it is a bacteria or virus acting upon bacteria and this depends upon the particular organisms concerned and the virus attacking the bacteria is specific for that organism, generally speaking.

Q. Is there any way of knowing, doctor, somewhat at least, how long, for instance, pathogenic bacteria which involves typhoid would live after its discharge into the open pond?

A. I think I might prefix that by stating the principles of survival would quite obviously be the same or essentially the same under these conditions in a pond as they would be under the form of sewage treatment in a conventional plant as a biological process and on this basis the survival of typhoid bacilli might be for considerable periods of time, depending upon whether a material was frozen in ice, whether it was on a hot summer day. We know that they can survive all winter certainly and thaw out of excrement in the woods and contaminate streams at that time giving rise to typhoid fever or even outbreaks of typhoid, so during the wintertime one wouldn't expect there to be nearly as rapid a death rate of these organisms as there might be in the summertime, but in general the curve would decrease in this order, there would also be a tendency for a few pathogenic bacteria as typhoid to remain for quite long periods of time. Certainly I would expect them in excess of three or four months, maybe even six months to a year.

Q. Doctor, speaking now of your pathogenic bacteria in regard to tuberculosis, how long would they live?

A. I don't know exactly how long they would live, they are quite a resistant organism to ordinary environmental effects.

Q. Is there any way, doctor, you could state whether it would be hours, days or weeks?

A. Oh, I should express the opinion

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that it would be a matter of several months that they could survive.

Q. Now getting over to the pathogenic virus which contain polio, could you tell us how long they might live after being discharged into the pond?

A. I have no information as to the survival of poliomyelitis virus in such an area, it is difficult to demonstrate this virus except by its effect on tissue cultures. This has been done but I don't happen to know of studies on sewage other than fresh sewage to indicate the presence of virus. It presumably could be done by concentration techniques but this is the more common method of doing it today rather than to inject monkeys—in any event it is quite a variable process for the isolation of the viruses and they vary in their survival time. The hepatitis virus is probably one of the most resistant ones and this hepatitis virus has been known to survive at room temperature in plasma for six months—actually for nine months at higher temperatures it doesn't survive as well. This is true in general biological things, that the survival is decreased by the higher temperatures.

Q. In your opinion, doctor, would the polio virus last for more than a week?

A. I should expect it to last more than a week, yes.

Q. Dr. Ziegler, I think yesterday when we left off we were discussing to some extent the length of time these various pathogens live in sewage discharged into this raw sewage pond. I don't know that we asked you how long in your opinion pathogenic virus of encephalitis or sleeping sickness might live in a raw sewage pond after being discharged at the inlet?

A. I think some of the virus could live for very extended periods, a year or more. We know little of the survival from such conditions but I think they could survive for a period of at least a year.

Q. And in your opinion how long could the pathogenic bacteria of dysentery live?

A. You are speaking of the protozoa of dysentery?

Q. I think yesterday you gave us both the protozoan type and bacteria type and I wonder if you would give us an opinion on both of them?

A. The protozoan type in my opinion could live for more than a year,

certainly up to two years; the bacillary type I think should live or would live for three to six months.

Q. Now with such pathogens in a raw sewage pond, doctor, would it be possible for them to infect humans?

A. Yes, sir.

Q. And how might they infect humans?

A. They could infect humans through any mechanisms whereby man might come into contact with them, either in contact with the raw sewage itself in the pond, with any object which had been in the pond and taken out, through water fowl that may have been in and out along the farms, through mosquitoes that might carry virus such as encephalitis to considerable distances, through various rodents that might have access to this area, either along the edge or certain types of rodents that might get in a little farther.

Health Department Viewpoint

Harvey G. Rogers, director of Water Pollution Control for the State Dept. of Health and executive engineer for the Minnesota State Water Pollution Control Commission, also testified. The following are portions of his testimony.

Q. Do you believe that a lagoon such as East Grand Forks is building, properly operated and maintained, would be a likely source of contamination from which diseases might be transmitted to the public?

A. On the basis of my experience and qualifications that I described yesterday I do not believe that it would be a likely source of disease transmission to the public.

Q. Even after you reduce it to the effluent as we discharge it you still have the pathogens present in the effluent, do you not?

A. You have a hazard of the pathogens surviving the period in the pond.

Q. And that is one of the reasons why you do not approve putting the effluent into water that is used for recreational purposes, is that right?

A. Yes.

Other Testimony

Another witness was W. Van Heuvelen, a sanitary engineer and acting director of the North Dakota State Department of Health. He was asked "... do you have an opinion as to the likelihood of diseases be-

(Please turn to page 237)



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Protective Substation Grounding

BRUCE J. ENNIS

Principal Engineer,

Burns & McDonnell Engineering Co.,
Kansas City, Missouri

ADEQUATE protective grounding should be provided at all electrical substations to insure the safety of station operators and maintenance personnel during normal conditions as well as at times when short circuits or line to ground faults occur. In addition, low resistance grounds are necessary to provide an easy path for the discharge currents from lightning arresters, thus contributing to the reduction in voltage stress on station equipment from lightning or transient surges.

The principal objective in the design of a substation grounding system is to provide a uniform potential surface within and around the station which is as near zero earth potential as practicable, including the surfaces of all equipment, metallic structures, and other parts of the station not associated with the carrying of live circuit currents. By maintaining a uniform ground potential on all such surfaces, there will be no difference in potential between adjacent surface areas sufficient to cause injury to operating personnel, even during fault conditions.

Generally speaking, the earth's surface has a very high resistivity when compared with the low resistance of metals, such as, for example, a buried copper conductor. Due to this high resistance, all currents flowing from one point to another, through the earth, create an appreciable voltage drop, or voltage gradient, within a comparatively short distance; and an operator, standing with his feet apart on a line between these two points on the earth's surface, might be subjected to a considerable shock from the difference in potential between his two feet, especially during moments when heavy fault currents might be flowing. Such a condition would not exist if the two points in question were connected by a buried copper conductor of sufficient capacity to carry the fault current with only a negligible voltage drop.

In order to provide such a flat, and uniform ground potential gradient, it is common practice to surround the substation area with a buried main ground bus loop, connected by various cross-tie cables to form a buried ground grid at a depth of from 6 to 18 inches. This grounding network, connected to ground rods reaching down to permanently moist earth levels, serves as a common equi-potential, low resistance bus for the connection of individual grounding conductor leads from station equipment such as oil circuit breaker frames, transformer tanks, equipment housings, substation structure steel columns, manual switch operating mechanisms, fence, lightning arresters, overhead static wires and other metallic surfaces except parts normally carrying current.

The size of the ground bus should be adequate to carry the maximum fault current that is likely to flow in the ultimate development of the substation, for a nominal period of thirty seconds, without injury to the connections. The required circular area of copper ground bus conductors may be calculated as follows:

for bolted joints

$$A = 10.6I\sqrt{S}$$

for welded joints

$$A = 8.7I\sqrt{S}$$

where

A = circular mil area of copper ground bus

I = maximum sustained fault current flow to ground

S = time of current flow in seconds

These formulae are based on an initial temperature of 26°C and a permissible temperature rise of 250°C for bolted and 450°C for brazed or welded connections, respectively.

The common bus grid should extend outside of the fence line and should be connected to multiple driven ground rods, metallic water piping, well casings, ground plates, etc., as required to lower the ground resistance of the bus to one ohm, (or less if economically feasible), for high capacity substations, and to

5 ohm or less for small substations. If soil conditions prevent the driving of ground rods, it may be necessary to bury strip electrode cables radially outward from the ground bus loop to serve as a ground counterpoise. Copper connections between cables and ground rods should be made with high conductivity bolted clamps or by thermite welding, and all cable crossing points should be bonded together. Ground rods should reach well below the frost line since the resistivity of frozen earth in the winter will be very much higher than normal summertime earth resistivities.

Ground rods and plates should not be located in rivers, lakes, etc., where potential gradients might prove injurious to human or animal life.

Fences should be provided with their own ground rods and bus, with ties at frequent intervals to the main station ground network. Gaps across gates or removable fence sections should be bridged by buried ground cables.

Ground leads from lightning arresters should be as short as possible, and a local ground rod field should be driven directly below the arresters. The local ground field should be connected to the main station grounding network by at least two cables.

Obviously, the number of ground rods required to achieve a given station ground bus resistance, and the depth to which they must be driven, will depend on local conditions of the soil at the station site. Average resistivities of the ground for various earth conditions may be considered to be approximately as follows, in lieu of definite information on earth conditions at individual substation sites:

Ground Classification	Resistivity, Ohm-Meters
Wet organic soil	10
Moist soil	10 ²
Dry soil	10 ³
Bed rock	10 ⁴

According to these values, as presented in a paper by Reinhold Rudenberg on grounding principles, the resistivity of dry soil might be expected to be 100 times as great as

the resistivity of wet organic soil. When two or more rods are driven in multiple to obtain the desired station ground bus resistance, they should be spaced apart at intervals of at least six feet. This is desirable since approximately 90 percent of the total resistance to individual ground rods occurs within six to ten feet of the electrode. With proper spacing, to prevent overlapping of current paths away from the electrodes, the combined resistance of multiple rod grounds will vary approximately inversely as the number of rods.

In view of the fact that the resistance of a station grounding network will vary considerably between wet and dry seasons, it is desirable to conduct field tests, periodically, to determine the station ground resistance on existing substations as well as on newly constructed stations at various times during the year. Such tests are necessary to determine the adequacy of grounding protection for station personnel and for correct functioning of electrical equipment such as lightning arresters.

The simplest method for making such tests is in the use of a portable ground tester of the battery or hand - cranked magneto - powered type. Such a test set, which gives direct readings in ohms, will permit measurements of resistance to earth of installed rods, pipes, ground grids, metallic structures and the like, as well as measurement of resistance values for determining the average resistivity of the earth at given substation sites.

• • •

Cost of Handling Water Accounts

The cost of handling the average bill per year as reported by the Bureau of Water Works of Portland, Oregon, for the year ending June 30, 1959, was \$2,8653. For meter reading and service inspection, the average cost was \$1,5473; for accounting and billing 73.29 cents; for collection expense 18.60 cents; for postage 16.64 cents; for other expense 21.45 cents; and for maintenance of commercial office equipment 1.82 cents. Of the \$2,8653 total, \$2,3276 was for payroll expense and 12.37 cents for transportation.

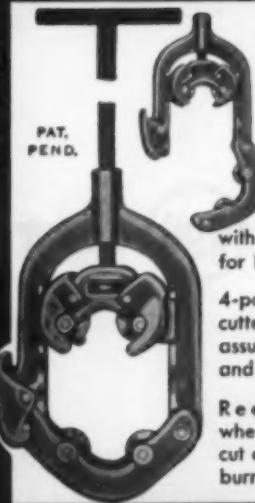
The unit cost of supplying water was 13.16 cents per 100 cu. ft. Of this, 8.70 cents was for operation and maintenance; 1.29 cents for other operating costs; 1.11 cents fixed charges (bond interest); and 0.01 cent for amortization of bond discount and cost of bond sales.

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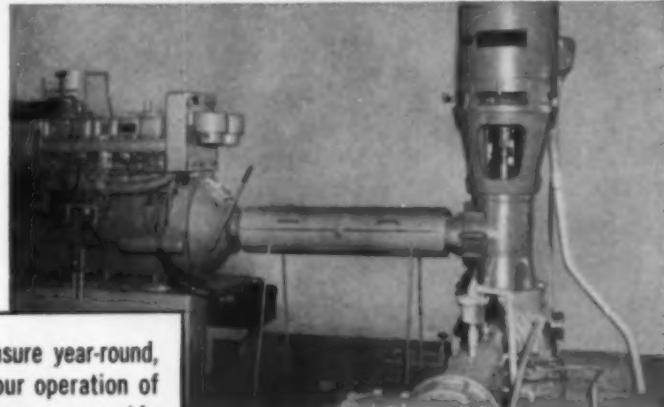
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American Welded Wire Fabric selected to



This is a 6-foot section of 144" elliptical concrete pipe. It has a greater flow capacity than its equivalent in round pipe and it can be installed in a minimum depth of cut with increased depth of cover. Elliptical pipe saves headroom—allows sufficient cover to reduce frost heave.

Lamar Pipe & Tile Division, American-Marietta Company, Grand Rapids—Pipe Manufacturer

L. W. Edison Company, Grand Rapids, Michigan—Contractor



USS American Welded Wire Fabric conforms perfectly to the elliptical shape of the 144" pipe. Because of the machine pre-fabricated accuracy of **USS American Welded Wire Fabric**, cages can be formed faster, and the spacing and concentricity of cages can be accurately controlled.

strengthen concrete pipe on Michigan Highway job

The Michigan State Highway Engineers faced a problem when it came to the selection of pipe for an important new highway in Berrien County. Hydraulic and grade line considerations dictated pipe with maximum water-carrying capacity with a low flow line, but with up to 33 feet of back fill. They selected over 1,000 linear feet of elliptical, reinforced concrete pipe. Diameters varied from the smallest to the largest—18" to 144".* Lamar Pipe & Tile Division, American-Marietta Company, manufactured the pipe.

In the case of the 480 feet of 144" required to withstand 33 feet of backfill, the specifications required 3 lines of reinforcement—an inner and outer cage each having 0.754 square inches per foot, and an elliptical cage having an area of 1.508 square inches per foot. Lamar Pipe & Tile elected to use American Welded Wire Fabric on this big job.

Concrete pipe manufacturers insist on quality reinforcing, meeting rigid specifications—that's why so many of them use **USS American Welded Wire Fabric**. This quality product—with its machine-made accuracy, assures the proper distribution of steel because the wire diameters are held to the close tolerance of $\pm 0.003"$ and their spacing may not vary by more than $\frac{1}{4}"$ center-to-center. This prefabricated product is more accurate than other forms of reinforcing. Its cold-drawn, high-tensile steel wires have a minimum yield point of 60,000 psi and a minimum ultimate strength of 75,000 psi. For more information, write to American Steel & Wire, 614 Superior Avenue, N.W., Cleveland 13, Ohio.

*Round equivalent

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To increase the strength of the pipe, by resisting diagonal tension, 320 $\frac{1}{2}"$ diameter stirrups are attached through the three cages of **USS American Welded Wire Fabric**.

PROJECTIONS SHOW MUNICIPAL USE OF GATE VALVES AND HYDRANTS WILL NEARLY DOUBLE BY 1975

WALTER L. PICTON
Director, and
A. T. LEVIE
Industrial Specialist,
Water and Sewerage Industry
and Utilities Division,
Business and Defense Services
Administration, U. S. Department
of Commerce

ABOUT 1,080,000 tons of Iron-Body Bronze-Mounted (IBBM) gate valves and 798,000 tons of IBBM hydrants will be installed and in use by 1975 in the public water and sewerage utilities of the Continental United States (not in-

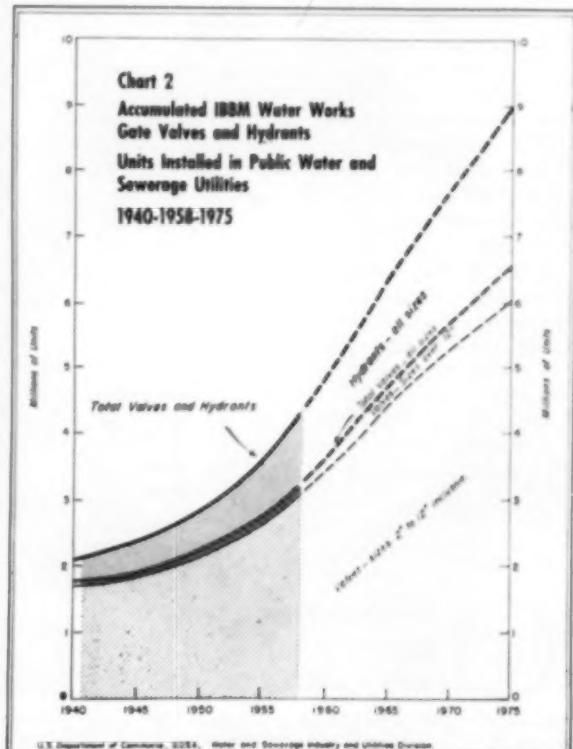
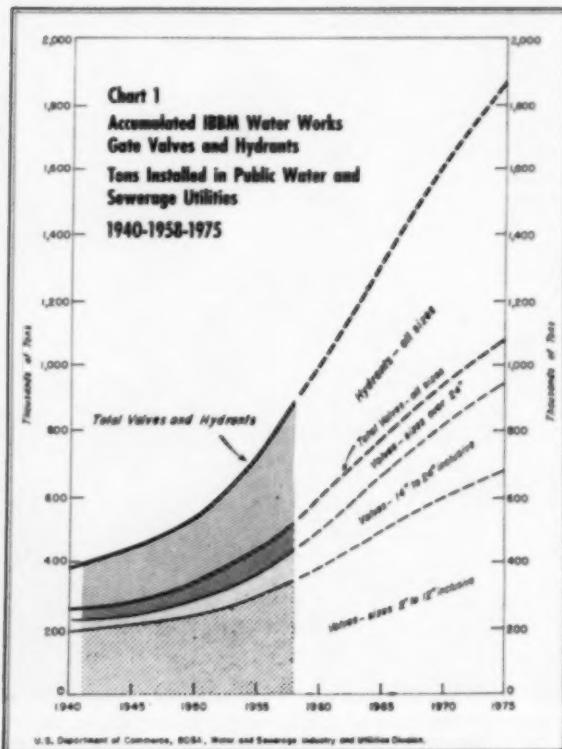
cluding Alaska), according to estimates in a recent study made by the Water and Sewerage Industry and Utilities Division of the Business and Defense Services Administration.

A detailed and exhaustive analysis of the national annual requirements for gate valves and hydrants for water and sewer mains and related uses has been released under the title "Water Utilities Requirements for IBBM Gate Valves and Hydrants, 1940-1958-1975." (Copies are available from the Superintendent of Documents, Washington 25, D. C., for 10 cents each.)

This article, based on that study,

presents estimates of the accumulation of IBBM gate valves and hydrants presently installed and in use in the Nation's public water and sewerage utilities. It presents the general trend of the past 20 years in quantity of valves and hydrants in use in the public water and sewerage utilities, with a projection for future years. It does not include the gate valves and hydrants in use by industries, Federal Government installations, and other miscellaneous users.

The presentation includes a breakdown by weight and by number of units, by size classes and by actual sizes. The study is based upon sta-



CHARTS prepared by the BDSA show tremendous increase in valve and hydrant installations by public works utilities.

istics and estimates from a number of sources. It is designed primarily as an aid to producers of valves and hydrants in planning production programs. The data will also be of interest to executives of public water utilities for comparison of their own existing installations and future expansions with those of other utility systems.

For convenience of study, the sizes of the IBBM gate valves have been divided into three size classes: 2 to 12 inches; 14 to 24 inches; and over 24 inches in diameter. Allowance has been made, in estimating the number in the 12-inch to 24-inch sizes, for the frequent use of one size smaller valve than the pipe main in which it is installed. Similar allowance has been made in sizes over 24-inch diameter where most of the valves installed are one or even two sizes smaller than the mains.

The projections of estimated installations to 1975 represent a trend

based on the same annual requirements developed in the previous study. They are designed primarily to illustrate the volumes that will be required by projection of present trends of expansion of utility facilities. Although individual years may vary from the general trend because of various factors, the picture in general is believed to be sufficiently representative for national planning for production, to supply the requirements for current maintenance and repair and replacement for obsolescence.

Basis For Estimates

In the aforementioned study, estimates were developed of the annual requirements for gate valves and hydrants for new construction, and for maintenance and replacements. These same estimates were also used to develop the accumulated increase in installed quantities after due allowance for depreciation and obsolescence.

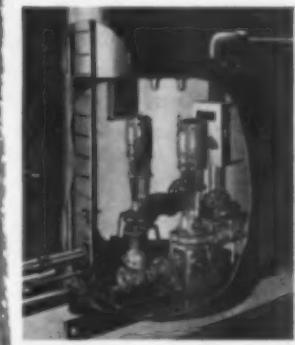
Table 1—Estimated Accumulation of IBBM Water Works Gate Valves and Hydrants Installed in Public Water and Sewerage Utilities

Year		Amounts in Thousands of Units				Hydrants in Use	
		Valves in Use					
		2" - 12"	14" - 24"	Over 24"	Total		
1940	Amount	1,714.0	37.8	9.0	1,760.8	377.1	
	Percent	97.3	2.2	0.5	100.0		
1945	Amount	1,847.5	47.5	9.1	1,904.1	498.0	
	Percent	97.0	2.5	0.5	100.0		
1950	Amount	2,143.4	71.2	9.6	2,224.2	618.8	
	Percent	96.5	3.1	0.4	100.0		
1953	Amount	2,394.2	97.2	9.8	2,501.2	788.7	
	Percent	95.7	3.9	0.4	100.0		
1955	Amount	2,621.9	115.3	10.0	2,747.2	890.9	
	Percent	95.4	4.2	0.4	100.0		
1958	Amount	3,453.1	155.5	10.4	3,255.9	1,090.5	
	Percent	94.9	4.8	0.3	100.0		

Table 2—Estimated Pattern of Sizes of IBBM Water Works Gate Valves by Number of Units Presently Installed and in Use by U. S. Water Utilities—1958

2" to 12"		14" to 24"		Over 24"	
Size	Percent	Size	Percent	Size	Percent
2	2.8	14	3.4	30	38.9
3	1.1	16	52.5	36	40.1
4	6.2	18	1.3	42	6.6
6	59.7	20	28.6	48	14.2
8	17.6	24	14.2	60 and over	0.2
10	4.2
12	8.4

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Comparisons of the estimates of the number of valves and hydrants were made with the results of other surveys and reports and with annual reports by many public water utilities, on the basis of valves per mile of mains and per 1,000 people served. From these reports, it was possible to develop the estimated size pattern within each of the major size classes.

Projections to 1975

Demands for extensions of service to new and old homes represent a major percentage of the increase in water distribution systems, and result in a corresponding increase in number of valves and hydrants installed.

Accordingly, the population projection (1) is the primary foundation for estimating the future increase in the number of valves and hydrants installed. It is assumed that an increasingly larger percentage of the population growth will locate in urban areas. A gradual but slight decrease in the number of persons per household (United States Census Bureau) forms the basis for the estimated increase in number of customers, with due allowance for residential retirements and conversions. It is also estimated that the percentage of the metropolitan

fringe population, or "urban sprawl," can be expected to increase in the next 20 years.

Reference

1. Illustrative Projections of the Population of the United States, by Age and Sex, 1960-1980," Series P-25, No. 187, November 10, 1958, Bureau of the Census, U. S. Department of Commerce, Series IV, P. 8.

• • •

Salt Stabilization by Michigan Counties

Among the Michigan counties that have had recent experience with salt stabilization are Macomb, Otsego and Muskegon. Following good results from a test road, the Macomb county commission constructed these projects during the 1959 season:

Two miles on the road from Mound to DeQuindre as a stage construction project later to receive a higher type wearing course. This strip carries a daily traffic volume of 2000 vehicles, including workers at two automobile manufacturing plants and also heavy trucks carrying steel and gravel. Stabilization by maintenance crews included ditching, addition of four inches of gravel, addition of 24 tons of salt a

mile and a prime and double seal. The work was carried on in two stages of one mile each. Cost of the project was \$8,510.

A section 3½ miles long on Capac Road between Armada Center and the county line to the north. This strip carries between 150 and 200 vehicles a day, including local farm trucks. No ditching was required, but six inches of 22A gravel and 24 tons per mile of salt were added. The project was primed and double sealed. Total cost was \$11,371.

Three miles on Romeo Plank Road toward Armada Center. Rural traffic on this strip is light. Salt and labor to construct the project cost \$2,896, plus \$600 a mile for a single seal and pebbles.

The Otsego County Road Commission experimented with salt in 1958 on a 3-mile section west of Gaylord. This road serves farm to market traffic. Only three inches of gravel was placed. Salt was added at the rate of 20 tons per mile on a 20-foot base. The work was done by county maintenance crews at a total cost of \$2,219.94 or \$739.98 per mile. Two months later, the road was primed and double sealed at a cost of \$2400 a mile.

The Muskegon County Road Commission began salt stabilization

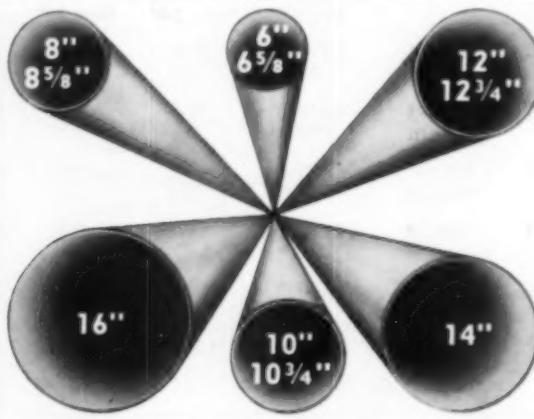
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Sizes: 6" 6 1/2" 8" 8 1/2" 10" 10 3/4" 12" 12 1/4" 14" 16" in wall thicknesses to .219.

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experiments in 1956. Salt stabilization projects constructed during 1958 and 1959 are: 1 mile on Pontaluna Road; one-fourth mile on Sheridan Road; one-half mile on East Fruitport Road; one-half mile on Skeels Road; one-fourth mile on Ravenna Road; three-quarters mile on Canada Road; and one-fourth mile on Trent Road.

Another experiment by the Muskegon county commission on a 2½-mile section employs a combination of salt, lime and fly ash. The commission introduced lime for its cementing qualities and fly ash to help alleviate breaking-up caused by freezing and thawing cycles. The road was primed with MCO and given a double seal of MC3, along with an application of 31B stone. The reconstructed road is 20 feet wide and was built at a cost of \$21,500, exclusive of the cost of the lime and fly ash. The project was broken into five one-half mile sections, all of which had varying quantities of salt, lime and fly ash, with one section in which no salt was introduced. After a year's use, the section without salt failed and was crumbly. The four sections in which salt was incorporated have stood up well with very little break up. The road will be under observance and study for sometime before final conclusions can be drawn on economy of the mixtures.

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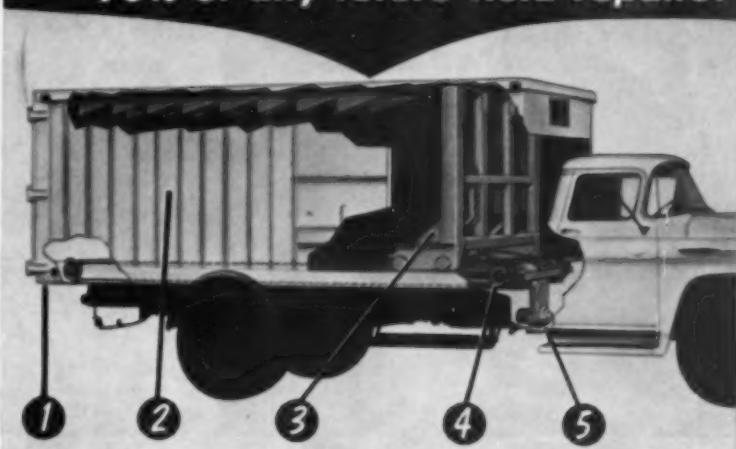
Louisville Merchants Capitalize on New Street Lighting System

Merchants in Louisville, Ky., have capitalized on the installation of modern fluorescent street lighting, using 50 GE luminaires which were turned on at the start of the Christmas shopping season. The project was a whirlwind affair, taking only 4½ months from inception to completion. On July 10, 1959, Mayor Bruce Hoblitzell proposed modern, fluorescent lighting for several downtown areas on a cost-sharing basis. He offered to have the city pay for half of the new lighting equipment and installation costs, plus maintenance and power charges to Louisville Gas and Electric. The merchants would pay for half of the initial cost only. Within six weeks Market street merchants had raised \$15,000—assuring the relighting of five blocks. The new four-lamp units were mounted on existing poles at a height of 30 feet with a 10 degree uplight. Spaced 100 feet apart opposite, they replace previous small mercury-vapor units. Each fixture supplies about 40,000 lumens.

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- 3 Stabilized, bulldozer-type packer plate travels on four huge rollers running in heavy guides — lets you pack anything without pre-crushing or fear of damage to packing mechanism or plate.
- 4 Powerful cable arrangement uses only two bottom cables, with simple reeving, prolongs cable life. Note absence of fast-wearing, noisy chains.
- 5 Fully enclosed drive has powerful, dependable winch coupled with fast electric clutch — provides years of consistent, trouble-free operation.

What a secure feeling to know that just \$150 in spare parts will cover 90% of any trouble you'll ever have with an M-B Packer. What's more — practically all repairs can be handled by your own mechanics or local garage personnel — no need to wait for special factory-trained people to get your unit back on the job.

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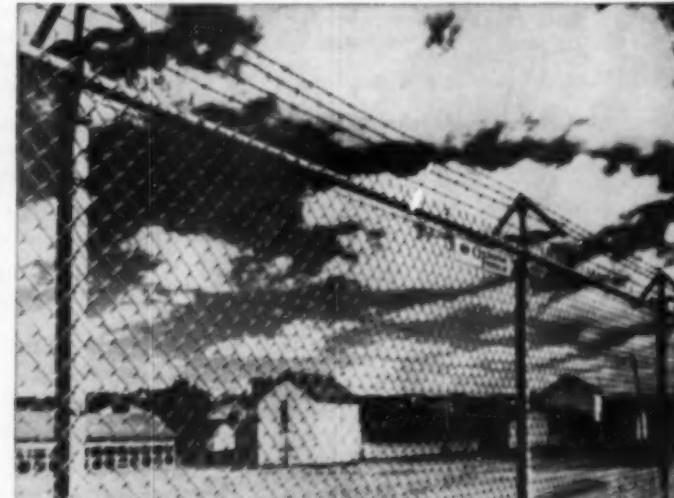
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Sewage Lagoon Testimony

(Continued from page 227)

ing transmitted from a properly maintained and operated—a properly designed lagoon plant?" His reply was "There is no likelihood." He was followed by Dr. J. K. Neel, regional biologist of the Public Health Service, who holds bachelor, master and doctor degrees in zoology. Questions and replies included:

Q. Then I will ask you, Dr. Neel, whether or not from work that you have done and your experiences, studies that you have made, have you formed an opinion as to the likelihood of disease being transmitted from a properly maintained and operated lagoon type pond?

A. I don't believe I can answer that yes or no.

Q. What is your opinion, doctor?

A. The thing you must always consider when you are dealing with sewage that contains human wastes, human fecal matter, is that there is always a chance that something can develop from that that would be inimical to the health of people. The job of sewage treatment is to reduce that chance as much as possible. In the absence of analyses that will definitely tell us whether or not pathogenic organisms exist in sewage or in the effluent from various types of sewage treatment plants is one of the things that makes that and we still consider this a possibility; when bacteriology and virology proceed to the point where we can adequately analyze for these pathogenic forms in sewage then we may be able to say that there is no possibility of disease transmission here at this place, but until that time comes all we try to do is reduce the possibility, reduce the percentages of the possibility, and I feel that the lagoon method has reduced those possibilities or reduces those possibilities as much as, if not a little more—and I have some reason for believing in some instances it is a little more—than any other type of sewage treatment.

Q. Then is it your answer that there is a possibility of disease being transmitted?

A. When you are dealing with this substance that you are talking about we don't know that we have eliminated that possibility.

Q. I understand, doctor, do you have an opinion as to whether there is a likelihood of diseases being transmitted from a properly maintained and operated plant?



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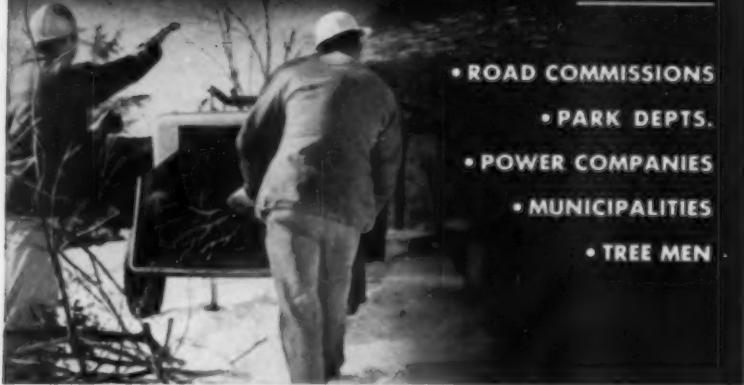
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A. There again I would say that a lagoon reduces the probability in my opinion more than any other type of sewage treatment.

Q. Is it your opinion, doctor, that a mosquito transmits diseases of virus, protozoa, bacteria by contact?

A. All diseases which are transmitted by mosquitoes with which I have come in contact it has been necessary for the mosquito to bite an infected person or infected animal in order to transmit the disease.

Q. And even after, doctor, the process that takes place in your treatment in a raw sewage pond we can assume that there are still pathogens present, can we not?

A. We can assume, I think, as is done by public health agencies whose responsibility is the protection of the public health that we get a reduction that is in ratio to the reduction shown in the coliform.

Q. Yes, but I don't want to mislead you on this question, we do have a reduction in them but we can assume that even after the treatment there is that reduced number of pathogens in the effluent?

A. That is the assumption that is made, although we have very few investigations that show the presence or absence of certain types of pathogens.

Q. Don't you, as a public health standard, assume that the pathogens are present?

A. We have to, it is necessary that we do.

Q. And it too is the recommendation of the Public Health Department that this effluent, because you assume it contains pathogens, should not be placed in waters used for drinking or recreational purposes without being treated?

A. That's right, all surface waters should be treated before they are used.

Q. Disease transmittal is one of the reasons that the survey was made on mosquitoes, is it not?

A. The major concern of the health agencies with mosquito breeding in lagoons was to determine what conditions were most favorable to mosquito breeding in lagoons and what mosquitoes are bred in lagoons; I don't believe that the possibility of mosquitoes by contact with the liquid in the lagoon spreading a disease by contact then with some person was considered and in all

instances—and I have worked with mosquitoes during the war for four years—in the transmission of virus and protozoan diseases I don't know of any instance which a mosquito transmits a disease in which it is not necessary for the mosquito to bite an organism that has the disease and then transfer it to another organism by biting it.

NEWS OF ENGINEERS

LOUIS R. HOWSON, Chicago consulting engineer, has been named "Chicago Civil Engineer of the Year" by the Illinois Section ASCE.

SAMUEL M. CARDONE has been appointed Chief of the Maintenance Operations Division, Michigan State Highway Department.

GEORGE N. SHAW, formerly Director of Finance of Miami, Fla., and before that city manager of Coral Gables, Fla., has joined Wainwright & Ramsey, municipal consultants, as vice president.

WESSON H. MILLER has joined the staff of Benjamin E. Beavin Co., Baltimore, Md. Mr. Miller, a civil engineering graduate of the University of Maryland, has specialized in highway bridge and interchange design.

THOMAS H. COLLINS has been appointed General Manager of the Water Works Board of Birmingham, Ala., succeeding E. CLINTON SMITH who becomes Manager of the East St. Louis and Interurban Water Co.

CAMP, DRESSER & MCKEE, Consulting Engineers, have moved to 18 Tremont St., Boston 8, Mass.

ANTHONY MAURIELLO has joined the staff of Engineers Incorporated, Newark, N. J., as Engineering Administrator.

JOHN R. KEMP, a registered professional engineer and a graduate of the University of Iowa, has joined the Lindsey Engineering Co., Minneapolis, Minn.

RANDAL L. GARTEN, previously public health engineer for Clay Co., Missouri, and a graduate of the Missouri School of Mines & Metallurgy, has joined Municipal Service Co., Kansas City, Mo.

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R. M. TUTTON heads temporarily the Division of Engineering of the Iowa State Highway Commission; CARL F. SCHACH heads the Division of Planning and JAMES F. HOAG the Division of Services. Many other changes have been made in the Commission.

Bowe, Albertson & Associates, consulting engineers, have opened a New England office at 1000 Farmington Ave., West Hartford 7, Conn., with L. W. VAN KLEEK in charge.

A. ROGER KELLY is now associate of Fred S. Dubin Associates, consulting engineers, and is manager of the New York Office.

F. CLINTON WINTER, Jr., has joined the staff of Engineers, Incorporated, Newark, N. J.

ALFRED C. LEONARD has become a partner in the consulting firm of Malcolm Pirnie Engineers, New York City.

W. OTIS WRIGHT has been named Highway Engineer for the State of Nevada. JOHN BAWDEN and REUBEN ELDREDGE have been made Deputy Highway Engineers. All have had long service with the State Highway Department.

WILL J. LESSARD, VAN COURT M. HARE and C. M. FLINT have been elected Directors of Chas. T. Main, Inc., consulting engineers.

E. LAWRENCE CHANDLER has retired as Assistant Secretary of the American Society of Civil Engineers. He has done an outstanding job over the years and the ASCE and the engineers it serves will be losers by his retirement. As a token of the valuable services he has rendered, he will be the first recipient of the ASCE Professional Recognition Award, which will be presented to him at the Reno meeting in June. Mr. Chandler will continue to serve as Treasurer of ASCE.

WALT J. HANNA, Jr., has been elected president of the California Council of Civil Engineers and Land Surveyors. Mr. Hanna and his father practice civil engineering in Gilroy, Calif.

THOMAS M. WOOD, Jr., has become a member of the firm of Kech Engineering Associates, Atlanta 5, Ga.

HAROLD L. PLUMMER, recently chairman of the Wisconsin State Highway Commission, and WILLIAM L. HAAS, recently director of Ad-

ministration for the Commission, have formed the consulting firm of Highway Management Associates which will be devoted exclusively to highway administration and management. Offices will be in Madison, Wis.

S. O. LINZELL has resigned as Deputy Director of Operations of the Ohio Department of Highways and will rejoin the consulting engineering firm of Michael Baker, Jr., Inc., Rochester, Pa.

R. T. PATTERSON Co., Inc., consulting engineers, have opened an office in the Grant Bldg., Pittsburgh, Pa.

JAMES C. HARDING, Westchester Co., N. Y., Commissioner of Public Works, and HAROLD G. WILM, New York State Conservation Commissioner, have been made members of the New York State Temporary Commission on Water Resources Planning.

N. M. DEJARNETTE, long-time engineer of the Georgia Department of Public Health, and Associate Director of the Water Quality Service of that Department, has retired. He is now associated with Robert & Co. Associates, Consulting Engineers of Atlanta.

CHARLES M. BINGHAM has been elected vice president of Capitol Engineering Corp., consulting engineers of Dillsburg, Pa.

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Activated Sludge

(Continued from page 147)

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proper liquid-solids separation by means of gravity. It has been pointed out that surface area is the only controlling factor, therefore, the only item that need be considered is the settling rate of the solids, and the provision of an area such that the up-flow rate of the clarified liquid does not exceed the settling or subsidence rate of the suspended solids. For example, normal activated sludge can withstand an up-flow or rise rate up to 1 gpm per sq. ft. of clarification area and even higher. It is entirely possible to design clarification compartments and basins to provide such up-flow rates with a total retention time approaching 15 or 20 minutes. We know that the oxygen up-take rates of good mixed-liquor solids in an activated sludge system are such that with a dissolved oxygen level of 2 or 3 mg/L the dissolved oxygen will reach zero in 10 to 15 minutes or less. Therefore, if we are to minimize the effect of oxygen depletion on the aerobic organisms we must accomplish the liquid-solids separation step in certainly not over 30 minutes and preferably a shorter period of time.

In the activated sludge process there is an excess of organisms produced which must be continually

wasted and disposed of by various means. Waste sludge can be conducted to separate thickening devices of the gravity or of the dissolved air flotation type, and the necessary thickening accomplished without subjecting the entire mass of organisms to conditions of oxygen depletion for prolonged periods of time. In other words, there is no excuse for designing an activated sludge treatment plant to settle and thicken all the solids for prolonged periods of time, just in order to obtain a relatively thick sludge for purposes of waste and disposal. Such thickening of waste sludge can be accomplished more efficiently and economically in a piece of equipment which is not part of the treatment system itself. The trend to design activated sludge treatment plants in this manner is now definite.

The Aero-Accelerator

In attempting to design and develop equipment for using the completely-mixed system, and to incorporate the above mentioned principles of liquid-solids separation, it became apparent that many of the desired features are present in the solids-contact type of water treatment unit. By introducing a turbine

type of air disperser, it was possible to adapt the water treatment "Accelerator" mechanism to the completely-mixed activated sludge system, and also obtain quick liquid-solids separation. A design of this unit as adapted from the water treatment unit is called the "Aero-Accelerator" treatment plant. This unit has been widely used for domestic sewage treatment and also for treatment of organic industrial wastes having BOD values of the order of 700 to 800 mg/L and less.

The basic design factors that establish the size and volume of an "Aero-Accelerator" are the total aeration volume necessary for handling the biological load and the clarification area that must be provided for accomplishing liquid-solids separation. In general, for domestic sewage, a design factor of 250 lbs. per day of BOD per 1000 cu. ft. of aeration volume is used for establishing the volume of mixed-liquor solids. The clarification area is established on a basis of the settling characteristics of the mixed liquor, and for ordinary activated sludge, as obtained from domestic sewage, a maximum overflow rate of one gpm per sq. ft. can be used. Air requirements are calculated on the basis of the BOD loading, the oxygen required per lb.

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of BOD removed, and the oxygen absorption efficiency of the aeration system, which in this case is a turbine type aerator dispersing compressed air, and with which oxygen absorption efficiency of the order of 25 percent can be obtained.

Industrial Wastes

When handling high-strength industrial wastes, it becomes uneconomical to design equipment in this manner. For such high strength wastes most of the volume in any tank would be aeration volume, since the hydraulic loading would be relatively small, and therefore, the clarification area would be small compared to the entire area of the basin. A different type of "Aero-Accelerator" was designed with the aeration volume and the clarification area substantially reversed in position. The large outside area became aeration volume and only the small center area is used for clarification and liquid-solids separation.

The completely-mixed system is receiving wide acceptance by engineers charged with designing industrial waste treatment plants. There are large units installed at six oil refineries, the primary purpose of such treatment units being the removal of various phenolic compounds.

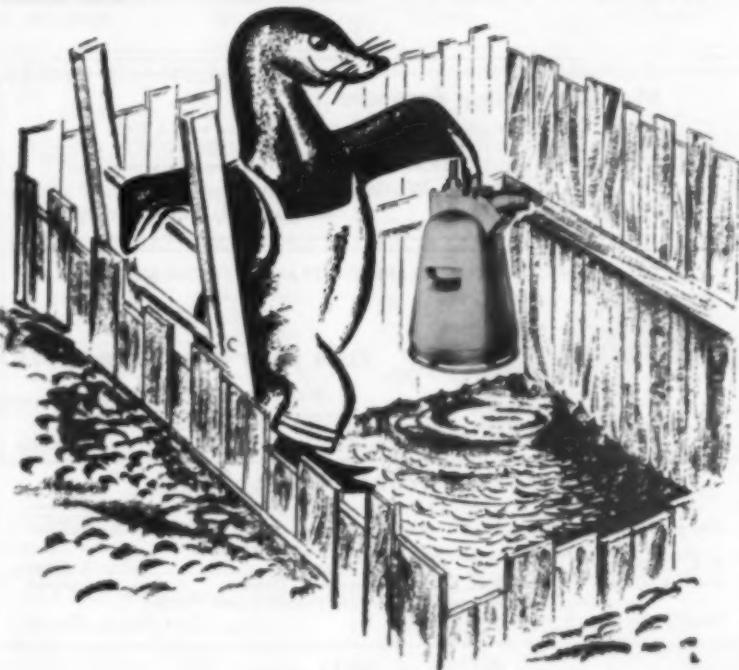
The largest single completely-mixed activated sludge treatment unit that has been built to date is the 110-ft. diameter "Aero-Accelerator" for the Whipppany Paper Company at Whipppany, New Jersey. This was designed to handle a flow of 3500 gpm of a waste water having a BOD of about 350 mg/L. It is equipped with a turbine type air disperser capable of handling up to 3500 cfm, driven by a 150-hp motor.

On the basis of pilot plant studies made by Stack and Conway (4), the consulting engineers are designing a completely-mixed activated sludge treatment plant for handling the sewage from S. Charleston, W. Va., and the waste water from Union Carbide Chemicals Company. The plant is to have two 90-ft. dia. units. The consulting engineers, Latham and Finney, reported that on an evaluated basis the completely-mixed activated sludge system was considerably more economical than either the conventional activated sludge system or a trickling filter plant.

The development of the completely-mixed process has greatly increased the attractiveness of the activated sludge method, both technically and economically for treatment of sewage and particularly for the biological treatment of organic

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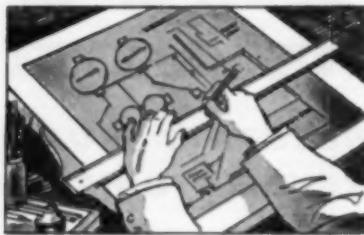
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industrial wastes. The new system permits organic loadings of 4 to 6 times those that can be used with the conventional treatment system.

It would appear that this scheme is one of the most significant developments since the activated sludge process was first applied to sewage treatment some 40 to 50 years ago.

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• • •

Municipal Refuse Practices

(Continued from page 134)

10 cents; the highest, 67 cents; and the average, 17 cents. The majority of these do not include a complete sanitary landfill operation for disposal. These figures when averaged by population groups show a rather surprising uniformity, except that costs appeared to increase slightly with population.

Figures were provided by 36 municipalities on 1) the amount of refuse collected daily and 2) yearly cost of operation with detail sufficient to figure the cost of collection and disposal of each ton of refuse. The variation in cost reported was considerable, ranging from \$1.19 per ton (from a small community) to \$16.50 per ton (for one of the larger communities); the overall average cost per ton was \$5.56. Half of these 36 municipalities indicated some type of supervised disposal area. The low cost per ton for these 18 was \$1.30; the high figure \$16.50; and the average \$5.67.

Time and Motion Data: Enough data to estimate the number of residences each collection crew collected each week were provided by 49 communities. These data are shown in the accompanying table. A two-man collection crew is considered as standard when making refuse collection from either the alley or the curb in residential areas. When carry-out collection is fur-

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nished then one more man may be added to the crew. A national figure of 1.74 minutes is used as the average time necessary for one man to collect one residence. This figure has been found to include travel time also. Thus a two-man collection crew would collect a residence every 0.9 minute or about 66 residences each hour. During a 40-hour week, this crew could collect about 1320 residences on twice-a-week collection (66 x 40 ÷ 2); and about 1452 during a 44-hour week. A round figure of two minutes is generally used for planning purposes. Using this figure, a collection crew should collect about 60 residences per hour or about 1200 and 1320 respectively for a 40-hour and 44-hour week. In summary, a collection crew should collect between 1200 and 1452 residences each week when making twice-a-week collections.

Comparing this information with the tabulated data indicates that the cities in the higher population bracket tend to use their collection crews more economically. It also indicates that cities and towns in the lower population brackets could economically reassign or reapportion their collection routes or assign a refuse collection crew to do municipal work in addition to refuse collection activities. In some instances the residential route may require only two or three days each week with the business route requiring only a portion of each day, thus the crew would be free for other work.

Summary

Less than 50 percent of the communities reporting require special type and size containers, and the majority do not require specific separation of garbage from other refuse. As the cities increase in size, more of them require special type and size refuse containers.

Of the 88 communities having a regular system of refuse handling, 76.1 percent indicated municipal collection of refuse, and 86.6 percent of these have municipal collection in both business and residential areas.

Of the communities having a regular system of refuse handling 79.2 percent collected refuse daily in the business district and 47.8 percent collected refuse twice weekly in the residential areas.

The municipal fee system of financing was reported by 82.1 percent of the communities having a municipally operated collection program; by 28.6 percent of those having contract collection. Fee direct to the contractor was reported by 61.9 percent of those having contract collection.

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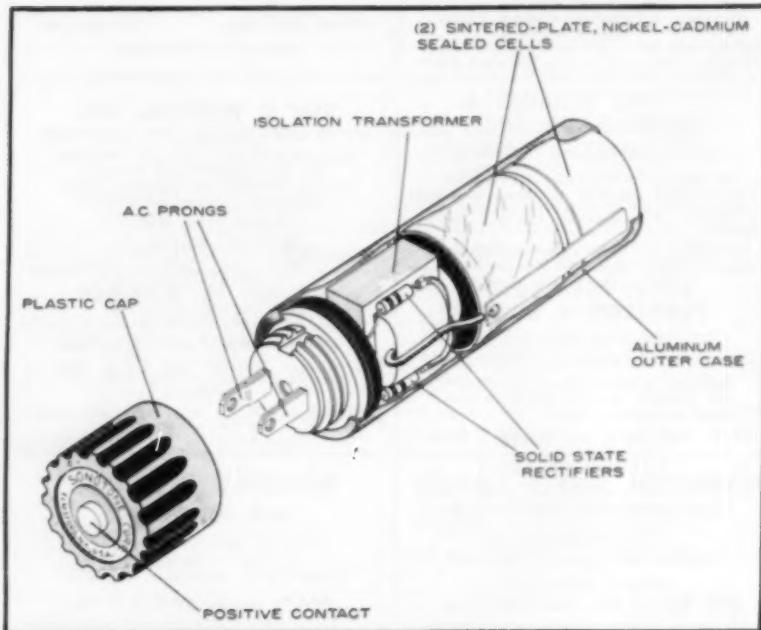
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PUBLIC WORKS EQUIPMENT NEWS



Cutaway drawing of rechargeable battery cartridge powered by cells end to end.

Rechargeable Battery

It is easy to recharge Sonotone's new flashlight battery cartridge. The top is unscrewed and the battery plugged into any 110-volt AC outlet. An overnight charging brings the battery back to operational capacity and the charging process can be repeated hundreds of times. The cartridge replaces two "D"-size standard batteries. The Sonotone

rechargeable battery is especially designed for those who need several hours of steady and reliable light from their flashlights. An overnight charge will give about three hours of continuous light; longer charging will increase the hours of light.

Sonotone Corp., Elmsford, N. Y.
Circle No. 5-1 on the convenient
reply card facing page 34.

Road Sweeper

A new road sweeper by Little Giant, the Road Bird, can be used with truck, Jeep or tractor as a tow-type sweeper; or it can be mounted on such units as a front-mounted sweeper. The front-mounted brush assembly sweeps 6, 7, or 8 feet. It is attached or detached as a unit by removing one pin. Speed of rotation of the brush is constant, controlled by governor settings, and is

entirely independent of speed of vehicle. The brush has easy adjustment for wear, angles 30 degrees right or left, and can be reversed for even wear. Optional accessories include electric starter, 4-wheel chassis, sprinkler system and pump, water tank up to 150 gallons, and dust shield for dustless operation.

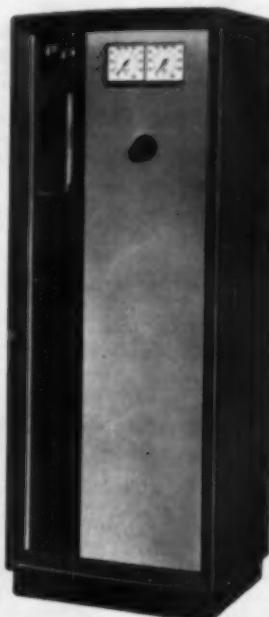
Little Giant Products, Inc., 1593
N. E. Adams St., Peoria, Ill.
Circle No. 5-2 on the convenient
reply card facing page 34.

New Chlorinator

This new Series 3400 line of Fischer & Porter provides manual or automatic control over capacity ranges from 0.1 to 2000 pounds per day. For protection against corrosion, the chlorinator is housed in fiberglass cabinets. The two-tone beige color is an integral part of the cabinet, completely eliminating painting or other maintenance. All piping and working parts are of plastics or corrosion resistant alloys, insuring immunity to chlorine attack. Controlomatic models of the new line accept electric, pneumatic, or vacuum signals from any type of metering device, and feed chlorine accurately according to proportional, start-stop, program, multiple rate or residual control requirements. A unique Vis-I-Flow valve permits visual observation of the rate valve.

Fischer & Porter Co., 467 Jacksonville Rd., Warminster, Pa.

Circle No. 5-3 on the convenient
reply card facing page 34.



Simplified design provides flexibility.



Rubber-Asphalt Joint Sealer

A new rubber asphalt joint sealer and crack filler offers a fast, economical way to seal out moisture, and dust. It bonds well to concrete, steel, masonry and other surfaces and remains flexible over a long period of time. Because it blends rubber and asphalt, it has a flexible quality which makes it possible for it to stretch as joints expand, and to withstand moisture. The sealer is sold in a standard tube which fits ordinary caulking guns and has a tip which can be cut to desired width of application. The color is black. Among the many uses which have been favorably reported are: Sealing foundation cracks, sealing around pipes which run through walls, filling cracks in driveways, sealing metal buildings, repairing roofs, gutters and roof parts—and many others.

United States Chemical Co., 1345 N. Building, Lincoln, Nebr.

Circle No. 5-4 on the convenient reply card facing page 34.

Maintenance Rollers

Shovel Supply Company 3 to 5-ton and 4 to 6-ton maintenance rollers are now equipped with heavy-duty 2-speed transmissions and torque converters. Instantly portable, these highly efficient rollers are quickly trailed at high speed from one job location to another on their own pneumatic wheels which are raised or lowered by power driven hydraulic cylinders attached to each wheel. The front end of the roller is also hydraulically raised for attaching to a truck for trailing. Steering is also hydraulic.

Shovel Supply Co., P.O. Box 1369, Dallas 21, Texas.

Circle No. 5-5 on the convenient reply card facing page 34.

Asphalt Surface Heater

A portable, lightweight asphalt surface heater that can be operated by one man has been announced by Essick. This new surface heater produces highly concentrated heat in a small area to heat asphalt quickly to a workable consistency. Available in two models, this compact unit has been specially developed for the repair and removal of asphalt bumps and push-ups, removal of traffic lane lines and for drying pot holes prior to patching. This surface



Curved Forms

Radi-Lok, a flexible steel form for pouring uniform curves in concrete, can be pre-set to hold any desired contour. It shortens set-up time, minimizes stripping effort, and practically eliminates surface finishing. Smooth and attractive facings for both inside and outside curves on low walls, sidewalks, curbs and gutters are possible with these light weight but strong forms. Radi-Lok is simple to use: set the stakes, select the curve by adjusting the band, and tighten the lock nuts. After pouring, the form can be re-positioned to repeat the same curve without any other adjustments. The forms come in 10-foot lengths with heights ranging from 4 to 24 inches. They may be joined in series to make up a variety of contours.

Binghamton Metal Forms, Box 848, Church St. Station, New York 8, N.Y.

Circle No. 5-6 on the convenient reply card facing page 34.

Stump Gobbler

This stump gobbler tractor attachment mounts on the rear of any standard tractor, takes power from the power takeoff shaft at 535 rpm, with the cutting teeth at 1,200 rpm. Total horsepower transmitted is between 30 and 42 hp. The unit chews up a stump in a few minutes with sixteen special saw blades. Small chips and sawdust pour out of its discharge opening in a continuous stream. A bag can be inserted to collect this material.

Myers-Sherman Co., Streator, Ill.

Circle No. 5-7 on the convenient reply card facing page 34.



Fence Light

For protection of property and increased plant security, these PLB Fresnel floodlights provide a band of light completely around an area, to discourage intruders. They combine wide horizontal beam spread with narrow vertical beam spread. Each floodlight is mounted on a pole approximately 30 feet from the fence; and they should be mounted so that beam patterns overlap. Mounting height for each installation depends upon results desired, and contours of the ground. Where the ground is level, a low mounting height is usually desirable, for projecting the light outward and providing maximum glare to an intruder.

Crouse-Hinds Co., Syracuse 1, New York.

Circle No. 5-8 on the convenient reply card facing page 34.

Seismic Timer



Instrumented sledge hammer finds depth of bedrock to 50 ft.

A transistorized seismic timer, made by DynaMetric, Inc., Pasadena, California, uses an instrumented sledge hammer to find depth to bedrock and explore earth structure to depths of fifty feet. The method, a simplified adaptation of techniques developed long ago in oil exploration, is based on measurement of the velocity of shock waves moving through surface and subsurface materials. Shock waves

are generated by sledgehammer blows against a steel plate. The timer measures arrival of the waves at a sensitive geophone. The battery-powered instrument, which reads shock wave travel time, totalized directly in milliseconds, weighs only 12 pounds.

DynaMetric, Inc., 2955 E. Colorado Blvd., Pasadena, Calif.

Circle No. 5-10 on the convenient reply card facing page 34.

Paver-Finisher



Contractor uses bituminous paver-finisher to place asphalt.

A small, highly mobile paver-finisher has rubber-tired wheels with paving speed ranges from 10 to 62 feet per minute and travel speed between jobs of 8 mph. There is no need to obtain special permits to move this black top paver, with a 4-ton capacity hopper, on a trailer.

Blaw-Knox Co., 300 Sixth Ave., Pittsburgh, Pa.

Circle No. 5-12 on the convenient reply card facing page 34.

Front End Loader

Latest addition to the Eimco 103 series of crawler-tractors is the 123 front end loader. This machine has a bucket capacity of 20,000 lbs. at carry position and maximum breakout force, with the bucket heeled on the ground, of 25,000 lbs. The sand and gravel bucket capacity has an SAE rating of 2 1/4 cu. yards; the rock bucket 2-cu. yard capacity and

2 1/4 yards heaped. Power is transmitted through "Unidrive" transmission and "Quadra-Torque," giving four speeds both in forward and reverse, flip-of-the-lever gear and direction changes, and a speed range of from zero to 6.5 mph.

Eimco Corp., Salt Lake City, U. S. A.
Circle No. 5-11 on the convenient reply card facing page 34.



Evaporator

A new instrument that meets the specification requirements of ASTM Designation D 1069-54T for automatic collection and concentration of water samples is now available. The Diamond continuous water sample evaporator will automatically collect, weigh-measure, concentrate and record as many as one million separate samples into a single, final sample of any desired concentration. Thus relatively simple and inexpensive purity test methods can be used to reveal purity (or impurity) levels thousands of times greater than possible using the same methods with random sampling techniques. The sample carrier assembly protects the sample in a platinum evaporating dish from all contamination at all times—even during transport from the evaporator to the test laboratory. Inlet water and heater controls are interlocked to prevent boiling of sample water at any time. In addition a manually set timer control is provided for concentrating the final sample to a minimum desirable volume.

Diamond Electronics, Lancaster, Ohio.

Circle No. 5-13 on the convenient reply card facing page 34.

A-C Power Unit

Allis-Chalmers has expanded its line of gasoline and natural gas engines with the addition of the G-138, a new 4-cycle, 4-cylinder, 128-cu. in. piston displacement unit that develops 39 bhp at 1800 rpm. The new engine is a companion to the Allis-Chalmers G-149 and G-226 engines. The G-138 power unit is 46 in. long, 18 15/16 in. wide, and 30 1/2 in. high to top of the radiator. The engine weighs 402 pounds and the power unit 622 pounds.

Allis-Chalmers Mfg. Co., Tractor Group, Milwaukee, Wisc.

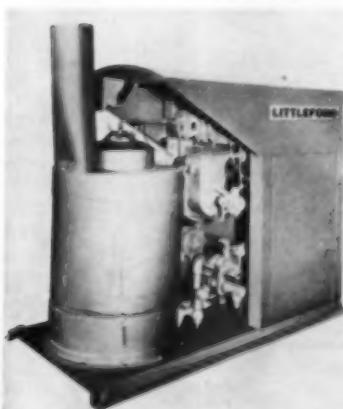
Circle No. 5-14 on the convenient reply card facing page 34.

Hot Oil Heater

The Littleford hot oil heater is a complete package ready to produce 450°F. hot heating oil without need of a protective building. The design utilizes the oil expansion tank under which is nested all operational controls and drives protected from the sides by removable doors. The heater is light weight, compact, easy to install, simple to operate and completely safe. The vertical down-fire coil type furnace permits forced air combustion with a cross flow of hot gases over the entire heating area. Positive circulation of the heat transfer oil in the heating area eliminates any cold or hot spots where deterioration of the oil could occur. A 24-hour timer permits complete automatic operation; heating is done at one time rather than periodically throughout the day. A pressure control shuts down the burner if a leak develops.

Littleford Bros., Inc., 457 East Pearl St., Cincinnati 2, Ohio.

Circle No. 5-15 on the convenient reply card facing page 34.



A unique method to remove water.

PUBLIC WORKS for May, 1960

Core Drill

An Acker high capacity core drill is available for mounting directly on a truck. Power for the unit can be furnished by separate, self-contained gasoline or diesel engines, or by direct power-take-off from the truck engine. This new truck mounted unit can be driven anywhere for soil sampling, mineral and petroleum exploration, water well drilling, highway construction, auger drilling, etc. Capacity is: Core drilling to 1000 feet; auger drilling to 300 feet; holes up to 24 inches in diameter.

Acker Drill Company, Inc., P. O. Box 830, Scranton 2, Pa.

Circle No. 5-16 on the convenient reply card facing page 34.



"Handle-Talkie" VHF Pocket Receiver.

Telescoping Tower



Tower can be removed, used separately.

A telescoping aluminum tower, Tallescope, mounted on electrically powered trucks facilitates the maintenance of roadside lighting standards by industries and municipalities throughout England. The tower, adjustable to reach heights up to 33 feet, folds down to a horizontal position for highway transport. Base legs are instantly adjustable to compensate for road camber and slope. Readily installed or dismounted from the truck, the tower can be used separately for overhead maintenance inside buildings while the truck is released for other duties.

Up-Right Scaffolds, 1013 Pardee, Berkeley, Calif.

Circle No. 5-17 on the convenient reply card facing page 34.

Pocket Receiver

A high powered, fully transistorized VHF pocket receiver, providing reliable voice communications, even in noisy locations, has been developed by Motorola. The new receiver is available for operation in the 25-54 megacycle and the 144-174 megacycle frequency bands—the standard two-way mobile radio channels. It weighs just over 10 ounces and can be worn in a pocket or clipped to the belt. It operates from either a rechargeable battery or from mercury cells. The rechargeable nickel cadmium supply provides up to 12 1/2 hours operation with each charge. The replaceable mercury cells last up to 125 hours.

Motorola, Inc., Communication & Industrial Electronics Division, 4501 W. Augusta Blvd., Chicago 51, Ill.

Circle No. 5-18 on the convenient reply card facing page 34.

Steep Grade Mowing

Heavy growth on 30 degree slopes is effectively mowed by this unit cutting up to a 60-inch swath in one pass. Designed for heavy duty mowing where grades and ground angles make mowing difficult, this rotary mower is available in 37, 48 and 60-inch widths with variable speed drive from 2 to 6 mph, one reverse independent of cutting unit. Three staggered heat treated steel cutting blades are mounted in a pivoted cutting unit designed to follow ground contour. Adjustable cutting height 3/4" to 4"; 9-hp four-cycle engine; 12 1/2-hp engine optional.

The Devere Co., Racine, Wisc.

Circle No. 5-19 on the convenient reply card facing page 34.

Hough Payloaders



This compact loader features four-wheel hydraulic brakes, sealed to keep dust out and offers clearance of 8 ft. 4 in. under the cutting edge with a 28 in. reach.

Reflective Traffic Buttons

A new lane-marking traffic button that stays put on highways, streets and crosswalks, is easy to apply and highly visible at night. Made of polysulfide base compounds and reflective glass beads, these markers have been under in-service tests since 1954. Even on heavily traveled highways, streets and crosswalks, these markers have shown a performance record of better than 99.98%—meaning that less than two out of every ten thousand have failed in the six-year period. The raised, reflective button surfaces offer improved visibility at night

and do not blank out even in rainy weather. Installation of the markers is relatively simple. The pavement must be clean and free of oil and dust. The chemically cured adhesive is mixed, and applied to the spot where the marker is to be placed. The button is then pressed in place. With pavement temperature of 70°F or higher the bond will be secure enough to reopen traffic within one hour. With lower temperatures or when traffic interruptions must be kept to minimum time, curing can be accelerated to a matter of minutes by the application of heat.

Thiokol Chemical Corp., 780 No. Clinton Ave., Trenton, N.J.

Circle No. 5-21 on the convenient reply card facing page 34.

Power Graders

The new Austin-Western power graders, the Pacer-400 and the Super-400, have 143-horsepower engines and both are in the 30,000-pound class. Features include: Power drive at all wheels; power steering at front and rear; power blade controls; power attachments; power transmission; power shift; and power reverse.

Austin-Western Works, Baldwin-Lima-Hamilton Corp., Box 170, Aurora, Ill.

Circle No. 5-20 on the convenient reply card facing page 34.



Wide range of accessories available for this grader include scarifier and plow.

The new Hough Model H-30 tractor shovel has an operating capacity of 3,000 lbs. and is equipped with a one cu. yd. bucket. The four-wheel-drive features the Hough full power - shift transmission with matched torque - converter. With three speed ranges in each direction, all shifts can be made "on-the-go" with no need to stop for "range" shifts. The H-30 is powered with a 77½ hp heavy-duty gas engine.

The series B models of the Hough H-70 and H-90 "Payloader" tractor-shovels have an operating capacity of 9,000 lbs., with the peak lift increased to 18,000 lbs. Additional power is provided by a new Cummins Turbo-charged diesel engine which develops 162 hp at 2,100 rpm. A GMC diesel, which develops 153 hp at 2,200 rpm is offered as an option.

Frank G. Hough Co., 761 Seventh Ave., Libertyville, Ill.

Circle No. 5-22 on the convenient reply card facing page 34.

Hoe for Truck Mounting

This power hoe can be mounted on any new or used 2-ton truck, either factory-mounted or for local mounting on the buyer's own truck. An all-weather backhoe cab is available. The hoe has 200° boom swing, digs 14 feet deep, has 20-ft. reach and 11-ft. dump clearance. Three independent hydraulic circuits of 25 gpm each are used. Fast-cycling hydraulic system lets the operator swing load 90° in about 2 seconds. Capacity is ½-yd. struck. All control valves on the HY-HOE 250 are cast in block.

Hydraulic Machinery Co., Waukesha, Wisc.

Circle No. 5-23 on the convenient reply card facing page 34.

Thickness Gage



New Miller spreaders are equipped with adjustment screw for fast setting.

A thickness gage is available which can be installed on all Miller towed pavers, and is part of original equipment on all new Miller spreaders. It makes quicker and easier thickness measuring in laying asphalt paving courses. By setting the screed adjustment screw to the level pointed out by the thickness gage indicator needle on the built-in thickness setting dial, the operator knows immediately the thickness of the asphalt from the start of the job. Adjustments can be made efficiently and easily to meet paving conditions right during the job. The screed crank hoist is another Miller spreader innovation. It provides rapid raising or lowering to control the desired thickness of material courses. Both of these new product developments can be fitted to any Miller paver.

Miller Spreader Corp., 4020 Simon Rd., Youngstown, Ohio.

Circle No. 5-24 on the convenient reply card facing page 34.

Pneumatic Tire Roller

The new 11-wheel American Road Runner, Model 11WG, provides 57.5 PSI rolling pressure and up to 295 pounds pressure per lineal inch of tire width. An automotive type hydraulic steering provides a fast turning cycle. Accessories include one 80-gallon or two 160-gallon water tank systems, working and running lights and 10 ply, 90 PSI tires with heavy duty flat base demountable rims.

American Steel Works, 1211 West 27th St., Kansas City 8, Mo.

Circle No. 5-25 on the convenient reply card facing page 34.

Contraction Joints

A new and economical method of forming contraction joints in concrete pavement is now available. Made from Geon vinyl, a product of B. F. Goodrich Chemical Company, the strips are composed of two sections, an outside V-shaped envelope and an inside T-shaped spreader strip. A strip inserting machine designed to follow directly behind the finishing machine vibrates the assembled strip into the concrete slab at the desired joint locations. When the concrete has set, the T-shaped spreader strip is removed from the V-shaped envelope. This allows the walls of the envelope to collapse thereby permitting easy removal from the concrete. The resulting joint is smooth and clean inside because the concrete does not cling to the vinyl strip. No oil or coating of any kind



Close-up view of joint former shows envelope closes with spreader removed.

is used on the plastic joint former. The Geon vinyl strips can be used many times without appreciable wear.

American Sisalkraft Corporation, Attleboro, Mass.

Circle No. 5-26 on the convenient reply card facing page 34.

Generators

A new series of bigger Winco engine generators are announced. These 7500-watt engine generators, designed for portable or standby use, produce 50% more power at a price near that of an ordinary 5000 watt unit. To make these new power units more practically portable, Wincharger has a Mobile-Pow-er trailer.

Wincharger Corp., Sioux City 2, Iowa.

Circle No. 5-27 on the convenient reply card facing page 34.

DEPENDABLE



The Tarco "Litter-Shark" is a full vacuum quality-built, push-type litter collector.

Vital metal parts of the "Litter-Shark" are guaranteed for one full year. The all steel suction impeller will even handle tin cans. You'll never have to replace a suction housing. The heavy, zippered canvas dust-control bag is patented.

The rugged, quality-built "Litter-Shark" assures long life, trouble-free operation. It's dependable.

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824-B North Bend Rd., Cincinnati 24, Ohio

Hydraulic Ladder



The Holan Series 2600-A Manual-Hydraulic ladder will replace the Series 2600 in the company's line of aerial ladders. While retaining the pushbutton control, the support frame construction has been changed from tubular to plate metal for added rigidity. Non-skid pierced metal pedestal step treads and relocation of the rotation crank to the left of the mast were changes made for added safety and ease of operation. The dual-level platform, which provides comfortable standing surfaces at all ladder angles, and 12,000-volt woodstrain insulators are standard equipment. The 2600-A is raised by pushing a button and lowered by turning a needle valve control handle located below the button box on the right side of the mast. As an optional feature, a pushbutton control permits ladder operation by the man on the platform. With remote control, a second button—for lowering the ladder—is included in the control station on the mast. The 2600-A is available in 28- and 32-foot heights, rotates 360° in either direction, and elevates to a 75° angle. Fiberglass covering of the side rails and knurled steel ladder rungs are optional.

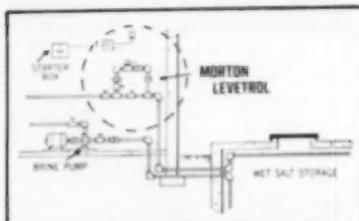
Holan Corp., 4100 West 150th St., Cleveland 35, Ohio.

Circle No. 5-28 on the convenient reply card facing page 34.

Salt in Water Softening

In a wet salt storage basin for water softening the liquid level should always cover the salt bed. In order to control efficiently the liquid level of the wet salt storage basin, the Morton Salt Company has developed the Levetrol which is available in several sizes and styles.

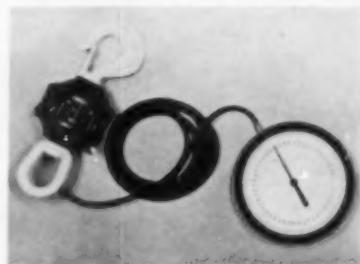
A typical Levetrol Kit would include the following equipment: Automatic reset timer, solenoid valve, flow controller and strainer. The liquid control parts are installed on the water supply line to the salt basin, while the automatic reset timer would be mounted nearby, or with other electrical controls. The timer is started by an electrical signal that indicates the use of a given quantity of brine. While the solenoid is open, water flows to the storage basin through the flow controller at a fixed flow rate. When the Levetrol is properly adjusted, the liquid level in the salt storage basin will follow the salt bed down, maintaining a predetermined liquid head above the salt. This feature automatically provides the necessary volume to prevent any overflow when a shipment of salt is unloaded.



Morton Salt Co., Industrial Division, 110 North Wacker Drive, Chicago 6, Ill.

Circle No. 5-29 on the convenient reply card facing page 34.

Remote Indicating Crane Scale



This new remote indicating crane scale weighs and handles material in one operation in an easy-to-handle, compact system. The load element and the indicator are provided as separate units connected by up to 50 ft. of flexible double wire braid hose. The load element can be picked up by a crane hook to any reasonable height and the indicator can be mounted at eye level where the operator can read accurately any load applied to the hook of the element. The element provides for automatic self-alignment under tension, has a high safety factor, 360° calibration and a 25% tare adjustment, on a space saving 12" dial.

Martin-Decker Corp., 3431 Cherry Ave., Long Beach 7, Calif.

Circle No. 5-30 on the convenient reply card facing page 34.

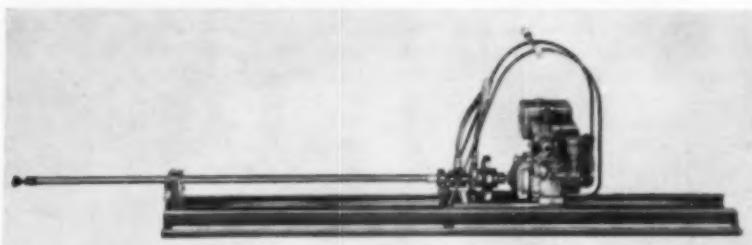
Power Earth Auger

Labor saving costs up to 50% are possible with the earth auger manufactured by Modern Products. Powered by either a 3 or 5.75-hp engine, this one-man operated unit will drill horizontally 200 feet or more, under lawns, shrubbery, walks, railroads, streets, buildings without disrupting traffic or damaging property; it even drills through frost, hardpan and gumbo. A 2-inch hole can be drilled laterally at the rate of 5 feet per minute.

Return drill bits are available in 4, 6, 8, 10 and 14-inch sizes in diameter. The power unit is mounted on ball bearing wheels, assuring easy movement along a 7-foot track. The augers use 5-foot sections of $\frac{3}{4}$ -inch pipe in drill stems. Additional 5-foot sections may be attached for precision drilling of 200 feet or more.

Modern Products, Inc., Exeter, Nebr.

Circle No. 5-31 on the convenient reply card facing page 34.



This portable, engine-driven auger removes loosened dirt by hydrodynamic action.

Cat Gas Engines

Increased horsepower ratings are announced for Caterpillar spark-ignition engines which operate on gaseous fuels. The increased output is possible through turbocharging and aftercooling, raising horsepower on the G397 to a continuous rating of 560 hp. The turbo-charged and aftercooled engines in the G375 and G342 sizes are 380 hp and 280 hp respectively for continuous operation. Fuel consumption at the rate of approximately 7000 btu (low heat value) per brake horsepower hour continuously is proof of engine performance. Factors which permit full production power continuously include the full length, water-cooled cylinder liners; aluminum pistons; oil jet cooling; and the piston design.

Charles E. Krosse, Caterpillar Tractor Co., Industrial Engine Plant, Peoria, Ill.

Circle No. 5-32 on the convenient reply card facing page 34.

Power Spade

This is a light weight highly portable trencher which digs a neat small trench 3 or 4 inches wide and to 24 ins. deep. It eliminates a lot of hand digging on small jobs and saves even more time. One man does the work, guiding the machine and regulating the depth. It digs straight or curved as desired; does not scar lawns; and digs no unnecessarily wide trench. Weight is 242 lbs.; engine is 3 hp; wheels are 12 x 3 ins.

Stampings, Inc., Rock Island, Ill.
Circle No. 5-33 on the convenient reply card facing page 34.



Depth of trench is set by handle on left side of 4-cycle engine-driven trencher.

Electric Plant

This new remote-starting electric generating plant has a certified rating of 2500 watts, and is available in two different outputs: 120-volt, 60-cycle, single-phase, 2-wire, AC; or 120/240-volt, 60-cycle, single-phase, 3-wire AC. Completely self-contained, this quick-starting generating plant will provide dependable emergency electric power to operate, within its rated capacity, most of the essential electrical needs of the modern home; the smaller hospital or institution; hotels; apartment buildings and offices; houseboats, mobile work shops, display vans, trailers . . . wherever a minimum of electric power is needed but the demand is for automatic operation. It weighs 178 lbs. and is compact; it is available for either gasoline or natural gas operation.

D. W. Onan & Sons, Inc., 2515 University Ave., S. E., Minneapolis 14, Minn.

Circle No. 5-34 on the convenient reply card facing page 34.

Tractor Roller Blade

The Viking roller blades are now available with International Harvester Utility, Farmall Cub and International Cub Lo-Boy tractors, for all types of lawn building, renovating and grounds maintenance work. Two models of the roller blades are available; the four-foot Model No. 44 for Cub and Cub Lo-Boy units with Fast-Hitch, and six-foot Model No. 66 for larger tractor sizes with three-point industrial hitch. The blade, mounted ahead of a grid-type roller, floats behind the tractor and levels and fine grades without constant adjustment. Clods, meanwhile, are evenly pulverized by the roller, which leaves a continuous pattern of moisture-retaining pockets. Optional attachments for both models include a seed or fertilizer spreader, and a scarifier for ripping hard-packed soil. Also available with the Model No. 66 is a rake bar, side bar and coulter blade attachment plus a roller blade carrier. For all-year use, the roller blade can plow snow and spread sand or salt on drives and walks, all in one operation. Dealers can now furnish roller blades with International Harvester I-240, I-340 and I-460 Utility tractors to add many new uses for tractor operators.

International Harvester Co., 180 No. Michigan Ave., Chicago 1, Ill.

Circle No. 5-35 on the convenient reply card facing page 34.

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WORTH SEEING



SEWER TUNNEL Tight squeeze in a new St. Louis sewer tunnel 50 ft. below the surface. International T-340 Four-in-One tractor is pushing shot rock. Tunnel is too narrow for tractor to turn in.



STOCKPILE In New Orleans at the municipal repair plant this Marion 35-M clamshell with a 50-foot boom and $\frac{3}{4}$ -yard bucket unloads railroad cars, stockpiles materials and also serves the ready-mix plant.



LANDSCAPING How the John C. Lodge Expressway in Detroit looks now and how it will look after a 2.1 mile section of it is landscaped this spring at a cost of \$90,000. The photograph shows a treeless area of the Expressway from an overpass while the other picture gives an artist's conception of the same stretch with 2,500 trees and shrubs planned initially.



NEW ENGINES Latest addition to Caterpillar Tractor Company's engine manufacturing facilities is this new plant near Moline, Ill. This makes nearly 3 million sq. ft. of planned area devoted to engines.



GRASS SEED "Behold the sower went forth to sow," but the sower of Biblical parable was never equipped to spray roadside areas with a slurry of good seed and fertilizer. Picture courtesy The Lawn Institute.

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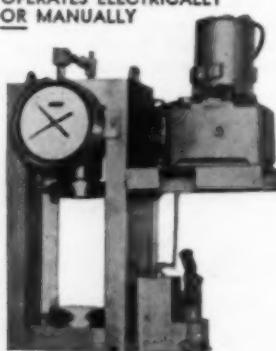
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by Arthur K. Akers

★ All of you who attend the American Water Works Convention in Bal Harbor, Fla., May 15-20 are cordially invited to come into PUBLIC WORKS' booths there, make yourselves known, and rest your feet!

★ Mueller Co. announces a major modernization and expansion program at Decatur, Ill. Over five million dollars will go into replacing more than half of the main plant structures, plus 261,500 square feet of new floor space.

★ The West Coast gets a new ARMCO corrugated metal pipe making plant, at Hillsboro, Ore.

★ Allis-Chalmers Mfg. Co. announce a multi-million dollar engine manufacturing plant at their Harvey Works, Illinois.

★ G. Kenneth Sinkinson, formerly district sales manager for Ludlow Valve Mfg. Co., joins George W. Hoyns Co., New York metropolitan area agents for Golden-Anderson Valve Specialty Co. and Rodney Hunt Machine Co.



Mr. Sinkinson



Mr. Countryman

★ David R. Countryman is named to the newly-created position of manager of research and engineering for Douglas Fir Plywood Association. Daniel H. Brown takes over Countryman's former duties as manager of applied research.

★ Edgar G. Paulson is new manager of process and waste water engineering for Hall Laboratories Div., Hagan Chemicals & Controls, Inc., Pittsburgh.

★ "Quick-Way" Truck Shovel Co., Denver, names Paul J. Wolfert director of sales.

★ A. G. Cochran is re-elected president of Clay Sewer Pipe Association.

★ Highway Equipment Co., Cedar Rapids, Iowa, appoints Clayton M. Porter division manager with seven-states responsibilities for sales of spreaders and pavers.

★ William E. Dickinson moves up to executive vice president, Calcium Chloride Institute, Washington. He retains his former position of chief engineer with all of the Institute's field engineers and technical activities under his direction.

★ Ted Nemes of Kerrigan Iron Works Co., a subsidiary of Rockwell-Standard Corp., announces a plant expansion program at Nashville to step up lighting standards production. To move the new output he lists seven new sales representatives.

★ "The EimcoBelt Story" is the title of a new 16 mm. sound and color film offered by the Eimco Corp. on operations of the EimcoBelt continuous belt drum filter. For prints address their Audio-Visual Dept., Box 300, Salt Lake City 10, Utah.

★ Keasbey & Mattison Co., makers of asbestos cement pipe, announce the start of construction on a new pipe-making plant at Hillsboro, Texas.

★ Yardley Plastics Co., Columbus, Ohio, state they will increase production of plastic pipe with a new plant addition to be completed in July.

★ Sylvan L. Hanauer, P.E., is named as consulting engineer by Morse Boulger Inc., New York. His services will be available to other engineers on all phases of incineration.

★ Concrete Joint Institute is the official name of the association of premolded joint manufacturers formerly known as Expansion Joint Institute. Harry G. Meadows of W. R. Meadows Inc. is president.

★ Dick Ford of Ford Meter Box Co. contributes this gem: In Wabash, where Wilbur's son Dave is on the Council's street and alley committee, it became necessary to fire one of the street sweepers: "He was a dreamer and could not keep his mind in the gutter!"

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MF60-21

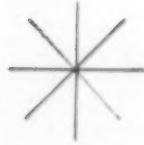
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